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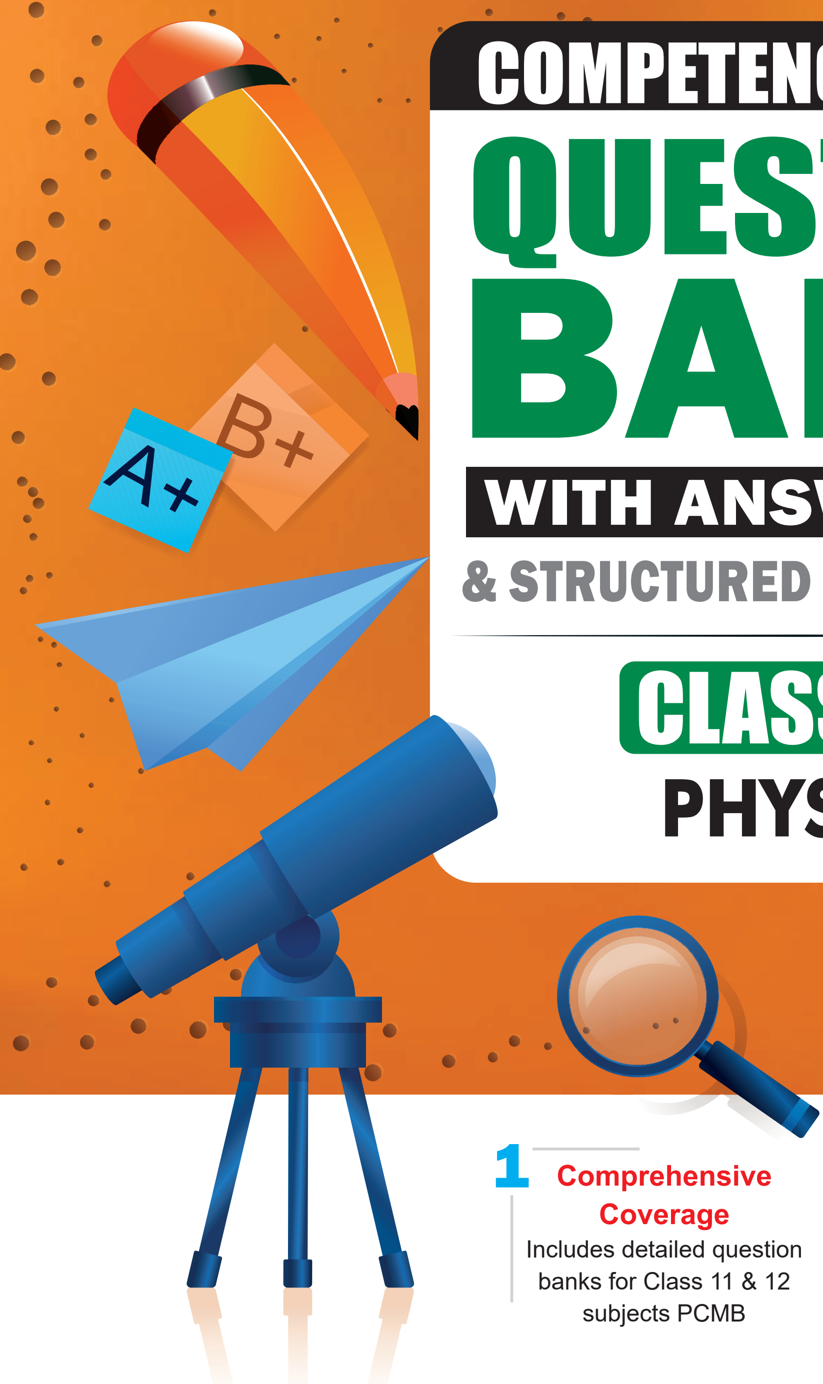

COMPETENCY-BASED QUESTION BANK

WITH ANSWER KEY & STRUCTURED EXPLANATION

CLASS 11

PHYSICS

FEATURES

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MOTION IN A PLANE

1. If a person can throw a stone to maximum height of h metre vertically, then the maximum distance through which it can be thrown horizontally by the same person is

a) $\frac{h}{2}$ b) h c) $2h$ d) $3h$

2. A pendulum bob on a 2 m string is displaced 60° from the vertical and then released. What is the speed of the bob as it passes through the lowest point in its path

a) $\sqrt{2}\ m/s$ b) $\sqrt{9.8}\ m/s$ c) $4.43\ m/s$ d) $1/\sqrt{2} m/s$

3. A wheel is subjected to uniform angular acceleration about its axis. Initially its angular velocity is zero. In the first 2 sec, it rotates through an angle θ_1. In the next 2 sec, it rotates through an additional angle θ_2. The ratio of $\theta_2\ /\theta_1$ is

a) 1 b) 2 c) 3 d) 5

4. A car is moving in a circular horizontal track of radius 10m with a constant speed of $10\ \text{ms}^{-1}$. The angle made by the rod with track is

a) Zero b) 30° c) 45° d) 60°

5. A cyclist is travelling on a circular section of highway of radius 2500 ft at the speed of 60 mile h^{-1}. The cyclist suddenly applies the brakes causing the bicycle to slown sown at constant rate. Knowing that after 8 s the speed has been reduced to 45 mileh^{-1}. The acceleration of the bicycle immediately after the brakes have been applied is

a) $2\ \text{ft/s}^2$ b) $4.14\ \text{ft/s}^2$ c) $3.10\ \text{ft/s}^2$ d) $2.75\ \text{ft/s}^2$

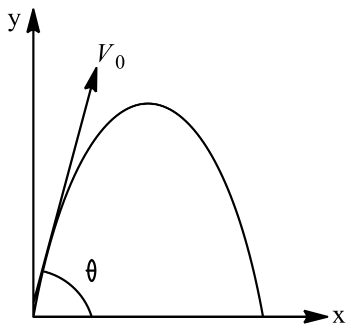
6. Two stones are projected from the same speed but making different angels with the horizontal. Their horizontal ranges are equal. The angle of projection of one is $\pi/3$ and the maximum height reached by it is 102 m. Then maximum height reached by the other in metre is

a) 336 b) 224 c) 56 d) 34

7. A particle moves in circle of radius 25 cm at the rate of two revolutions per second. The acceleration of particle is

a) $2\pi^2\text{ms}^{-2}$ b) $4\pi^2\text{ms}^{-2}$ c) $8\pi^2\text{ms}^{-2}$ d) $\pi^2\text{ms}^{-2}$

8. A small particle of mass m is projected at an angle θ with the x-axis with an initial velocity v_0 in the x-y plane as shown in the figure. At a time $t < \frac{v_0 \sin\theta}{g}$, the angular momentum of the particle is



a) $-mgv_0t^2 \cos\theta\ \hat{\mathbf{j}}$ b) $mgv_0t \cos\theta\ \hat{\mathbf{k}}$ c) $-\frac{1}{2}mgv_0t^2 \cos\theta\ \hat{\mathbf{k}}$ d) $\frac{1}{2}mgv_0t^2 \cos\theta\ \hat{\mathbf{i}}$

9. When a body moves in a circular path, no work is done by the force since

a) force and displacement are perpendicular other b) the force is always away from the center
c) there is no displacement d) there is no net force

10. Consider a vector $\vec{F} = 4\hat{\imath} - 3\hat{\jmath}$. Another vector that is perpendicular to $\vec{F}$ is

a) $4\hat{\imath} + 3\hat{\jmath}$ b) $6\hat{\jmath}$ c) $7\hat{\jmath}$ d) $3\hat{\imath} - 4\hat{\jmath}$

11. A particle is projected with a velocity 200 ms^{-1} at an angle of 60°. At the highest point, it explodes into three particles of equal masses. One goes vertically upwards with a velocity 100 ms^{-1}, the second particle goes vertically downwards. What is the velocity of third particle?

a) 120 ms^{-1} making 60° angle with horizontal b) 200 ms^{-1} making 60° angle with horizontal

c) $300 ms^{-1}$ d) $200 ms^{-1}$

12. The maximum height attained by a projectile is increased by 10% by increasing its speed of projection, without changing the angle of projection. The percentage increase in the horizontal range will be
a) 5% b) 10% c) 15% d) 20%

13. A motorcycle is going on an overbridge of radius R. The driver maintains a constant speed. As the motorcycle is ascending on the overbridge, the normal force on it
a) Increases b) Decreases c) Remains the same d) Fluctuates

14. A car is moving on a circular level road of radius of curvature 300 m. If the coefficient of friction is 0.3 and acceleration due to gravity $10 ms^{-2}$, the maximum speed the car can have is (in $km h^{-1}$)
a) 30 b) 81 c) 108 d) 162

15. A body of mass 5 kg is moving in a circle of radius 1 m with an angular velocity of 2 $radian$/sec. The centripetal force is
a) 10 N b) 20 N c) 30 N d) 40 N

16. If the sum of the two unit vectors is also a unit vector, then magnitude of their difference is
a) $\sqrt{2}$ b) $\sqrt{3}$ c) $\sqrt{4}$ d) $\sqrt{7}$

17. A force $\vec{F} = -K(y\hat{i} + x\hat{j})$ (where K is a positive constant) acts on a particle moving in the $x - y$ plane. Starting from the origin, the particle is taken along the positive x-axis to the point $(a, 0)$ and then parallel to the y-axis to the (a, a). The total work done by the force $\vec{F}$ on the particle is
a) $-2Ka^2$ b) $2Ka^2$ c) $-Ka^2$ d) Ka^2

18. A projectile can have the same range R for two angles of projection. If T_1 and T_2 be the times of flights in the two cases, then the product of the two times of flights is directly proportional to
a) $\frac{1}{R^2}$ b) $\frac{1}{R}$ c) R d) R^2

19. A projectile shot into air at some angle with the horizontal has a range of 200 m. If the time of flight is 5 s, then the horizontal component of the velocity of the projectile at the highest point of trajectory is
a) $40 ms^{-1}$ b) $0 ms^{-1}$
c) $9.8 ms^{-1}$ d) Equal to the velocity of projection of the projectile

20. If $\vec{A}=2\hat{i} + 3\hat{j} + 4\hat{k}$ and $\vec{B} = 4\hat{i} + 3\hat{j} + 2\hat{k}$, then angle between $\vec{A}$ and $\vec{B}$ is
a) $\sin^{-1}(25/29)$ b) $\sin^{-1}(29/25)$ c) $\cos^{-1}(25/29)$ d) $\cos^{-1}(29/25)$

21. A body slides down a frictionless track which ends in a circular loop of diameter D. Then the minimum height h of the body in terms of D so that it may just complete the loop, is
a) $h = \frac{5}{2}D$ b) $h = \frac{3}{2}D$ c) $h = \frac{5}{4}D$ d) $h = 2D$

22. A particle moves in a circular path with decreasing speed. Choose the correct statement
a) Angular momentum remains constant
b) Acceleration ($\vec{a}$) is towards the centre
c) Particle moves in a spiral path with decreasing radius
d) The direction of angular momentum remains constant

23. A stone of mass 1 kg tied to a light inextensible string of length $L = \frac{10}{3} m$ is whirling in a circular path of radius L in a vertical plane. If the ratio of the maximum tension in the string to the minimum tension in the string is 4 and if g is taken to be $10 m/\sec^2$, the speed of the stone at the highest point of the circle is
a) $20 m/sec$ b) $10\sqrt{3} m/sec$ c) $5\sqrt{2} m/sec$ d) $10 m/sec$

24. A body moves along a circular path of radius 5 m. The coefficient of friction between the surface of path and the body is 0.5. The angular velocity, in radians/sec, with which the body should move so that it does not leave the path is ($g = 10 ms^{-2}$)
a) 4 b) 3 c) 2 d) 1

25. Two particles of equal mass are connected to a rope AB of negligible mass such that one is at end A and other dividing the length of rope in the ratio 1 : 2from B. The rope is rotated about end B in a horizontal plane. Ratio of tensions in the smaller part to the other is (ignore effect of gravity)
a) 4 : 3 b) 1 : 4 c) 1 : 2 d) 1 : 3

26. The velocity of projection of an oblique projectile is $\vec{\mathbf{v}} = 3\hat{\mathbf{i}} + 2\hat{\mathbf{j}}$ (in ms^{-1}). The speed of the projectile at the highest point of the trajectory is

a) $3\ \mathrm{ms}^{-1}$ b) $2\ \mathrm{ms}^{-1}$ c) $1\ \mathrm{ms}^{-1}$ d) Zero

27. The centripetal acceleration of a body moving in a circle of radius 100 m with a time period of 2 s will be

a) $98.5\ \mathrm{ms}^{-2}$ b) $198.5\ \mathrm{ms}^{-2}$ c) $49.29\ \mathrm{ms}^{-2}$ d) $985.9\ \mathrm{ms}^{-2}$

28. A particle of mass m is moving in a horizontal circle of radius r, under a centripetal force $= \frac{k}{r^2}$, where k is a constant.

a) The potential energy of the particle is zero

b) The potential energy of the particle is $\frac{k}{r}$

c) The total energy of the particle is $-\frac{k}{2r}$

d) The Kinetic energy of the particle is $-\frac{k}{r}$

29. A plumb line is suspended from a ceiling of a car moving with horizontal acceleration of a. What will be the angle of inclination with vertical?

a) $\tan^{-1}\left(\frac{a}{g}\right)$ b) $\tan^{-1}\left(\frac{g}{a}\right)$ c) $\mathrm{cas}^{-1}\left(\frac{a}{g}\right)$ d) $\mathrm{cas}^{-1}\left(\frac{g}{a}\right)$

30. A monkey can jump a maximum horizontal distance of 20 m. Then the velocity of the monkey is

a) $10\ \mathrm{ms}^{-1}$ b) $14\ \mathrm{ms}^{-1}$ c) $20\ \mathrm{ms}^{-1}$ d) $24\ \mathrm{ms}^{-1}$

31. A ball is projected with kinetic energy K at an angle of 45° to the horizontal. At the highest point during its flight, its kinetic energy will be

a) K b) $K/\sqrt{2}$ c) $K/2$ d) Zero

32. A bullet fired at an angle of 30° with the horizontal hits the ground 3 km away. By adjusting its angle of projection, one can hope to hit a target 5 km away. Assume the muzzle speed to be same and the air resistance is negligible

a) possible to hit a target 5 km away b) not possible to hit a target 5 km away
c) prediction is not possible d) None of the above

33. A particle undergoes uniform circular motion. About which point on the plane of the circle, will the angular momentum of the particle remain conserved?

a) center of the circle b) on the circumference of the circle
c) inside the circle d) outside the circle

34. When a ceiling fan is switched on, it makes 10 rotations in the first 4 s. How many rotations will it make in the next 4 s? (Assuming uniform angular acceleration)

a) 10 b) 20 c) 40 d) 30

35. The adjacent sides of a parallelogram are represented by co-initial vectors $2\hat{\imath} + 3\hat{\jmath}$ and $\hat{\imath} + 4\hat{\jmath}$. The area of the parallelogram is

a) 5 units along z-axis b) 5 units in $x - y$ plane
c) 3 units in $x - z$ plane d) 3 units in $y - z$ plane

36. A body of mass m thrown horizontally with velocity v, from the top of tower of height h touches the level ground at distance of 250 m from the foot of the tower. A body of mass $2m$ thrown horizontally with velocity $\frac{v}{2}$, from the top of tower of height $4h$ will touch the level ground at a distance x from the foot of tower. The value of x is

a) 250 m b) 500 m c) 125 m d) $250\sqrt{2}$ m

37. For an object thrown at 45° to horizontal, the maximum height (H) and horizontal range (R) are related as

a) $R = 16H$ b) $R = 8H$ c) $R = 4H$ d) $R = 2H$

38. A stone is just released from the window of a train moving along a horizontal straight track. The stone will hit the ground following

a) Straight path b) Circular path c) Parabolic path d) Hyperbolic path

39. For a particle in uniform circular motion the acceleration **a** at a point $P(R, \theta)$ on the circle of the radius R is (here θ is measured from the x –axis)

a) $-\frac{v^2}{R}\cos\theta\,\hat{\mathbf{i}}+\frac{v^2}{R}\sin\theta\,\hat{\mathbf{j}}$
b) $-\frac{v^2}{R}\sin\theta\,\hat{\mathbf{i}}+\frac{v^2}{R}\cos\theta\,\hat{\mathbf{j}}$
c) $-\frac{v^2}{R}\cos\theta\,\hat{\mathbf{i}}-\frac{v^2}{R}\sin\theta\,\hat{\mathbf{j}}$
d) $-\frac{v^2}{R}\hat{\mathbf{i}}+\frac{v^2}{R}\hat{\mathbf{j}}$

40. A body is thrown with a velocity of 9.8 m/s making an angle of 30° with the horizontal. It will hit the ground after a time

a) 1.5 s
b) 1 s
c) 3 s
d) 2 s

41. A particle rests on the top of a hemisphere of radius R. Find the smallest horizontal velocity that must be imparted to the particle if it is to leave the hemisphere without sliding down it

a) $\sqrt{gR}$
b) $\sqrt{2gR}$
c) $\sqrt{3gR}$
d) $\sqrt{5gR}$

42. A small object placed on a rotating horizontal turn table just slips when it is placed at a distance of 4 cm from the axis of rotation, if the angular velocity of the turn table is doubled the object slips when its distance from the axis of rotation is

a) 1 cm
b) 2 cm
c) 4 cm
d) 8 cm

43. A particle is projected with velocity $2\sqrt{gh}$ so that it just clears two walls of equal height h, which are at a distance of $2h$ from each other. What is the time interval of passing between the two walls?

a) $\frac{2h}{g}$
b) $\sqrt{\frac{2h}{g}}$
c) $\sqrt{\frac{h}{g}}$
d) $2\sqrt{\frac{h}{g}}$

44. A can filled with water is revolved in a vertical of radius 4 m and the water does not fall down. The time period for a revaluation is about

a) 2 s
b) 4 s
c) 8 s
d) 10 s

45. The angular velocity of a wheel is 70 rad/sec. If the radius of the wheel is 0.5 m, then linear velocity of the wheel is

a) 70 m/s
b) 35 m/s
c) 30 m/s
d) 20 m/s

46. A stone is projected from the ground with velocity 50 m/s at an angle of 30°. It crosses a wall after 3 sec. How far beyond the wall the stone will strike the ground ($g = 10\ m/\sec^2$)

a) 90.2 m
b) 89.6 m
c) 86.6 m
d) 70.2 m

47. The co-ordinates of a moving particle at time t are given by $x = ct^2$ and $y = bt^2$. The instantaneous speed of the particle is

a) $2t(b+c)$
b) $2t(b+c)^{1/2}$
c) $2t(c^2-b^2)$
d) $2t(c^2+b^2)^{1/2}$

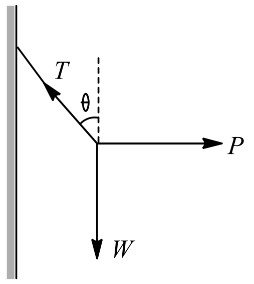
48. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion of the particle takes place in a plane it follows that

a) Its velocity is constant
b) Its acceleration is constant
c) Its kinetic energy is constant
d) It moves in a straight line

49. A circular road of radius 1000 m has banking angle 45°. The maximum safe speed of a car having mass 2000 kg will be, if the coefficient of friction between tyre and road is 0.5

a) 172 m/s
b) 124 m/s
c) 99 m/s
d) 86 m/s

50. A small sphere is hung by a string fixed to a wall. The sphere is pushed away from the wall by a stick. The force acting on the sphere are shown in figure. Which of the following statements is wrong?

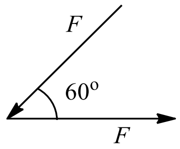


a) $P = W\tan\theta$
b) $\vec{T}+\vec{P}+\vec{W}=0$
c) $T^2 = P^2 + W^2$
d) $T = P + W$

51. An aircraft executes a horizontal loop with a speed of 150 m/s with its wings banked at an angle of 12°. The radius of the loop is ($g = 10\ m/s^2$, $\tan 12° = 0.2126$)

a) 10.6 km b) 9.6 km c) 7.4 km d) 5.8 km

52. Two forces, each equal to F, act as shown in figure. Their resultant is



a) $\frac{F}{2}$ b) F c) $\sqrt{3}\,F$ d) $\sqrt{5}\,F$

53. Radius of the curved road on national highway is R. Width of the road is b. The outer edge of the road is raised by h with respect to inner edge so that a car with velocity v can pass safe over it. The value of h is

a) $\frac{v^2 b}{Rg}$ b) $\frac{v}{Rgb}$ c) $\frac{v^2 R}{g}$ d) $\frac{v^2 b}{R}$

54. A particle is moving along a circular path with a uniform speed. How does its angular velocity change when it completes half of the circular path?

a) No change b) Increases c) Decreases d) Cannot say

55. A body moving along a circular path of radius R with velocity v, has centripetal acceleration a. If its velocity is made equal to $2v$, then its centripetal acceleration is

a) $4a$ b) $2a$ c) $\frac{a}{4}$ d) $\frac{a}{2}$

56. A body of mass 1 kg is rotating in a vertical circle of radius 1m. What will be the difference in its kinetic energy at the top and bottom of the circle? (Take $\mathrm{g} = 10\ \mathrm{ms^{-2}}$)

a) 10 J b) 20 J c) 30 J d) 50 J

57. In the case of an oblique projectile, the velocity is perpendicular to acceleration

a) Once only b) Twice c) Thrice d) Four times

58. A body of mass $m\ kg$is rotating in a vertical circle at the end of a string of length r metre. The difference in the kinetic energy at the top and bottom of the circle is

a) $\frac{mg}{r}$ b) $\frac{2mg}{r}$ c) $2mgr$ d) mgr

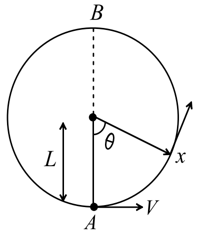
59. A body of mass 1 kg thrown with a velocity of 10 $\mathrm{ms^{-1}}$ at an angle of 60° with the horizontal. Its momentum at the highest point is

a) 2 kg $\mathrm{ms^{-1}}$ b) 3 kg $\mathrm{ms^{-1}}$ c) 4 kg $\mathrm{ms^{-1}}$ d) 5 kg $\mathrm{ms^{-1}}$

60. A stone is projected from the ground with velocity 50 $\mathrm{ms^{-1}}$ and angle of 30°. It crosses a wall after 3 s. How far beyond the wall the stone will strike the ground?

a) 80.5 m b) 85.6 m c) 86.6 m d) 75.2 m

61. A bob of mass M is suspended by a massless string of length L. The horizontal velocity V at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is half of that at A, satisfies



a) $\theta = \frac{\pi}{4}$ b) $\frac{\pi}{4} < \theta < \frac{\pi}{4}$ c) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$ d) $\frac{3\pi}{4} < \theta < \pi$

62. For a particle in uniform circular motion, thee acceleration $\vec{a}$ at a point $P(R, \theta)$ on the circle of radius R is (Here θ is measured from the x-axis)

a) $\frac{v^2}{R}\hat{\imath} + \frac{v^2}{R}\hat{\jmath}$ b) $-\frac{v^2}{R}\cos\theta\,\hat{\imath} + \frac{v^2}{R}\sin\theta\,\hat{\jmath}$

c) $-\frac{v^2}{R}\sin\theta\,\hat{\imath}+\frac{v^2}{R}\cos\theta\,\hat{\jmath}$ d) $-\frac{v^2}{R}\cos\theta\,\hat{\imath}-\frac{v^2}{R}\sin\theta\,\hat{\jmath}$

63. A man can thrown a stone 100 m away. The maximum height to which he can throw vertically is

a) 200 m b) 100 m c) 50 m d) 25 m

64. Roads are banked on curves so that

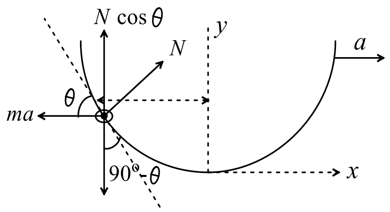
a) The speeding vehicles may not fall outwards

b) The frictional force between the road and vehicle may be decreased

c) The wear and tear of tyres may be avoided

d) The weight of the vehicle may be decreased

65. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y-axis vertical) with a bead of mass m on it. The bead can side on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x-axis with a constant acceleration a. The distance of the new equilibrium position of the bead, where the bead can stay at rest with respect to the wire, from the y-axis is



a) a/gk b) $a/2gk$ c) $2a/gk$ d) $a/4gk$

66.

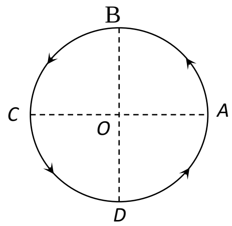


Figure shows a body of mass m moving with a uniform speed v along a circle of radius r. The change in velocity in going from A to B is

a) $v\sqrt{2}$ b) $v/\sqrt{2}$ c) v d) zero

67. A particle starts from the origin of coordinates at time $t = 0$ and moves in the $x - y$ plane with a constant acceleration α in the y-diretion. Its equation of motion is $y = \beta x^2$. Its velocity component in the x-direction is

a) Variable b) $\sqrt{\frac{2\alpha}{\beta}}$ c) $\frac{\alpha}{2\beta}$ d) $\sqrt{\frac{\alpha}{2\beta}}$

68. A body is revolving with a uniform speed v in a circle of radius r. The tangential acceleration is

a) $\frac{v}{r}$ b) $\frac{v^2}{r}$ c) Zero d) $\frac{v}{r^2}$

69. A project is projected with a velocity of 20 m/s making an angle of 45° with horizontal. The equation for the trajectory is $h = Ax - Bx^2$ where h is height, x is horizontal distance, A and B are constants. The ratio $A : B$ is ($g = 10\ ms^{-2}$)

a) 1 : 5 b) 5 : 1 c) 1 : 40 d) 40 : 1

70. If the equation for the displacement of a particle moving on a circular path is given by $(\theta) = 2t^3 + 0.5$, where θ is in radians and t in seconds, then the angular velocity of the particle after 2 sec from its start is

a) 8 rad/sec b) 12 rad/sec c) 24 rad/sec d) 36 rad/sec

71. Two masses M and m are attached to a vertical axis by weightless threads of combined length l. They are set in rotational motion in a horizontal plane about this axis with constant angular velocity ω . If the tensions in the threads are the same during motion, the distance of M from the axis is

a) $\frac{Ml}{M+m}$ b) $\frac{ml}{M+m}$ c) $\frac{M+m}{M}l$ d) $\frac{M+m}{m}l$

72. A bomber plane moves horizontally with a speed of 500 m/s and a bomb released from it, strikes the

ground in 10 sec. Angle at which it strikes the ground will be ($g = 10\ m/s^2$)

a) $\tan^{-1}\left(\frac{1}{5}\right)$ b) $\tan^{-1}\left(\frac{1}{2}\right)$ c) $\tan^{-1}(1)$ d) $\tan^{-1}(5)$

73. An electric fan has blades of length 30 cm as measured from the axis of rotation. If the fan is rotating at 1200 $r.p.m.$The acceleration of a point on the tip of the blade is about

a) 1600 $m/\sec^2$ b) 4740 $m/\sec^2$ c) 2370 $m/\sec^2$ d) 5055 $m/\sec^2$

74. A particle moves in a plane with constant acceleration in a direction different from the initial velocity. The path of the particle will be

a) A straight line b) An arc of a circle c) A parabola d) An ellipse

75. A force is inclined at 60° to the horizontal. If its rectangular component in the horizontal direction is 50 N, then magnitude of the force in the vertical direction is

a) 25 N b) 75 N c) 87 N d) 100 N

76. The maximum speed with which a car is driven round a curve of radius 18 m without skidding (where, g = 10ms^{-2} and the coefficient of friction between rubber tyres and the roadway is 0.2) is

a) 36.0 km h^{-1} b) 18.0 km h^{-1} c) 21.6 km h^{-1} d) 14.4 km h^{-1}

77. The equation of trajectory of a projectile is $y = 10x - \left(\frac{5}{9}\right)x^2$. if we assume $g = 10\text{ms}^{-2}$, the range of projectile (in metre) is

a) 36 b) 24 c) 18 d) 9

78. The minimum velocity at the lowest point, so that the string just slack at the highest point in a vertical circle of radius l

a) $\sqrt{gl}$ b) $\sqrt{3gl}$ c) $\sqrt{5gl}$ d) $\sqrt{7gl}$

79. The maximum height attained by a projectile when thrown at an angle θ with the horizontal is found to be half the horizontal range. Then θ is equal to

a) $\tan^{-2}(2)$ b) $\frac{\pi}{6}$ c) $\frac{\pi}{4}$ d) $\tan^{-1}\left(\frac{1}{2}\right)$

80. The magnitude of the centripetal force acting on a body of *mass m* executing uniform motion in a circle of radius r with speed v is

a) mvr b) mv^2/r c) v/r^2m d) v/rm

81. The kinetic energy K of a particle moving along a circle or radius R depends on the distance covered $s$as $K = a\,s^2$. The force acting on the particle is

a) $2\,a\,s\,R$ b) $2\,a\,s[1 + s^2/R^2]^{1/2}$ c) $2\,a\,s$ d) $2\,as^2/R$

82. A body is projected at an angle θ to the horizontal with kinetic energy E_k. The potential energy at the highest point of the trajectory is

a) E_k b) $E_k\cos^2\theta$ c) $E_k\sin^2\theta$ d) $E_k\tan^2\theta$

83. In a loop-the-loop, a body starts at a height $h = 2R$. The minimum speed with which the body must be pushed down initially in order that it may be able to complete the vertical circle is

a) $\sqrt{2gR}$ b) $\sqrt{gR}$ c) $\sqrt{3gR}$ d) $2\sqrt{gR}$

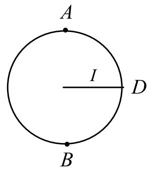
84. A stone is swinging in a horizontal circle 0.8 m in diameter, at 30rev/min. A distant light causes a shadow of the stone to be formed on a nearby wall. What is the amplitude of the motion of the shadow? What is the frequency?

a) 0.4 m, 1.5 Hz b) 0.4 m, 0.5 Hz c) 0.8 m, 0.5 Hz d) 0.2 m, 0.5 Hz

85. A particle is projected at an angle of 60° above the horizontal with a speed of 10 ms^{-1}. After some time the direction of its velocity makes an angle of 30° above the horizontal. The speed of the particle at this instant is

a) $\frac{5}{\sqrt{3}}\text{ms}^{-1}$ b) $5\sqrt{3}\ \text{ms}^{-1}$ c) 5 ms^{-1} d) $\frac{10}{\sqrt{3}}\text{ms}^{-1}$

86. A particle of mass m attracted with a string of length l is just revolving on the vertical circle without slacking of the string. If v_A, v_B and v_D are speed at position A, B and D then



a) $v_B > v_D > v_A$
b) Tension in string at $D = 3\ mg$
c) $v_D = \sqrt{3gl}$
d) All of the above

87. A car is travelling with linear velocity v on a circular road of radius r. If it is increasing its speed at the rate of $'a'm/s^2$, then the resultant acceleration will be

a) $\sqrt{\left\{\frac{v^2}{r^2} - a^2\right\}}$
b) $\sqrt{\left\{\frac{v^4}{r^2} + a^2\right\}}$
c) $\sqrt{\left\{\frac{v^4}{r^2} - a^2\right\}}$
d) $\sqrt{\left\{\frac{v^2}{r^2} + a^2\right\}}$

88. The acceleration of a vehicle travelling with speed of 400ms^{-1} as it goes round a curve of radius 160 m, is

a) $1\ \text{kms}^{-2}$
b) $100\ \text{ms}^{-2}$
c) $10\ \text{ms}^{-2}$
d) $1\ \text{ms}^{-2}$

89. A 500 kg car takes a round turn of radius 50 m with a velocity of $36\ \text{km h}^{-1}$. The centripetal force, is

a) 250 N
b) 750 N
c) 1000 N
d) 1200 N

90. If a cyclist moving with a speed of $4.9\ m/s$ on a level road can take a sharp circular turn of radius $4\ m$, then coefficient of friction between the cycle tyres and road is

a) 0.41
b) 0.51
c) 0.61
d) 0.71

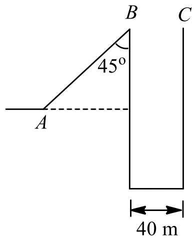
91. If $\vec{A} \cdot \vec{B} = AB$, then the angle between $\vec{A}$ and $\vec{B}$ is

a) 0°
b) 45°
c) 90°
d) 180°

92. The angular amplitude of a simple pendulum is θ_0. The maximum tension in its string will be

a) $mg(1 - \theta_0)$
b) $mg(1 + \theta_0)$
c) $mg(1 - \theta_0^2)$
d) $mg(1 + \theta_0^2)$

93. A body is projected up a smooth inclined plane with a velocity v_0 from the point A as shown in figure. The angle of inclination is 45° and top B of the plane is connected to a well of diameter 40 m. If the body just manages to cross the well, what is the value of v_0? Length of the inclined plane is $20\sqrt{2}\text{m}$, and $\text{g} = 10\text{ms}^{-2}$



a) $20\ \text{ms}^{-1}$
b) $20\sqrt{2}\text{ms}^{-1}$
c) $40\ \text{ms}^{-1}$
d) $40\sqrt{2}\ \text{ms}^{-1}$

94. A sphere of mass m is tied to end of a string of length l and rotated through the other end along a horizontal circular path with speed v. The work done in full horizontal circle is

a) 0
b) $\left(\frac{mv^2}{l}\right).2\pi l$
c) $mg.2\pi$
d) $\left(\frac{mv^2}{l}\right).(l)$

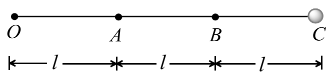
95. A bucket filled with water is tied to a rope of length 0.5 m and is rotated in a circular path in vertical pane. The least velocity it should have at the lowest point of circle so that water dose not spill is, $(g = 10\ \text{ms}^{-2})$

a) $\sqrt{5}\text{ms}^{-1}$
b) $\sqrt{10}\text{ms}^{-1}$
c) $5\ \text{ms}^{-1}$
d) $2\sqrt{5}\text{ms}^{-1}$

96. An object is projected at an angle of 45° with the horizontal. The horizontal range and the maximum height reached will be in the ratio

a) 1 : 2
b) 2 : 1
c) 1 : 4
d) 4 : 1

97. Three identical particles are joined together by a thread as shown in figure. All the three particles are moving in a horizontal plane. If the velocity of the outermost particle is v_0, then the ratio of tensions in the three sections of the string is



a) 3 : 5 : 7
b) 3 : 4 : 5
c) 7 : 11 : 6
d) 3 : 5 : 6

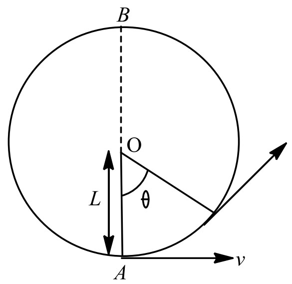
98. The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectile is

a) $\theta = \tan^{-1}\left(\frac{1}{4}\right)$ b) $\theta = \tan^{-1}(4)$ c) $\theta = \tan^{-1}(2)$ d) $\theta = 45°$

99. A man can throw a stone to a maximum distance of 80 m. The maximum height to which it will rise in metre, is

a) 30 m b) 20 m c) 10 m d) 40 m

100. A bob of mass M is suspended by a massless string of length L. The horizontal velocity v at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is half of that at A, satisfies



a) $\theta = \frac{\pi}{4}$ b) $\frac{\pi}{4} < \theta < \frac{\pi}{2}$ c) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$ d) $\frac{3\pi}{4} < \theta < \pi$

101. Given that centripetal force$F = -k/r^2$. The total energy is

a) $-k/r^2$ b) k/r c) $-k/2r^2$ d) $-k/2r$

102. The wheel of toy car rotates about axis. It slows down from 400 rps to 200 rps in 2s. Then its angular retardation in rads^{-2} is

a) 200 π b) 100 c) 400 π d) None of these

103. The magnitude of resultant of three vectors of magnitude 1, 2 and 3 whose directions are those of the sides of an equilateral triangle taken in order is

a) zero b) $2\sqrt{2}$ unit c) $4\sqrt{3}$ unit d) $\sqrt{3}$ unit

104. The horizontal range of a projectile is $4\sqrt{3}$ times its maximum height. Its angle of projection will be

a) 45° b) 60° c) 90° d) 30°

105. When a body moves in a circular path, no work is done by the force since,

a) There is no displacement
b) There is no net force
c) Force and displacement are perpendicular to each other
d) The force is always away from the centre

106. A particle is moving on a circular path with constant speed, then its acceleration willbe

a) Zero b) External radial acceleration
c) Internal radial acceleration d) Constant acceleration

107. When the road is dry and coefficient of friction is μ, the maximum speed of a car in a circular path is 10 ms^{-1}. If the road becomes wet and $\mu' = \mu/2$, what is the maximum speed permitted?

a) 5ms^{-1} b) 10 ms^{-1} c) $10\sqrt{2}$ ms^{-1} d) $5\sqrt{2}$ ms^{-1}

108. A particle is moving with a constant speed v in a circle. What is the magnitude of average after half rotation?

a) $2v$ b) $2\frac{v}{\pi}$ c) $\frac{v}{2}$ d) $\frac{v}{2\pi}$

109. A projectile is fired with a velocity v at an angle θ with the horizontal. The speed of the projectile when its direction of motion makes an angle β with the horizontal is

a) $v \cos\theta$ b) $v \cos\theta \cos\beta$ c) $v \cos\theta \sec\beta$ d) $v \cos\theta \tan\beta$

110. The radio of angular speeds of minute hand and hour hand of a watch is

a) 1 : 12 b) 12 : 1 c) 6 : 1 d) 1 : 6

111. Three vectors $\vec{A}, \vec{B}$ and $\vec{C}$ satisfy the relation $\vec{A} \cdot \vec{B} = 0$and $\vec{A} \cdot \vec{C} = 0$. If $\vec{B}$ and $\vec{C}$ are not lying in the same

plane then $\vec{A}$ is parallel to

a) $\vec{B}$ b) $\vec{C}$ c) $\vec{B} \times \vec{C}$ d) $\vec{B} \cdot \vec{C}$

112. A car of mass 2000 kg is moving with a speed of 10 ms^{-1}on a circular path of radius 20 m on a level road. What must be the frictional force between the car and the road so that the car does not slip?

a) 10^4N b) 10^3N c) 10^5N d) 10^2N

113. The vectors $\vec{a}$ and $\vec{b}$ are such that $|\vec{a} + \vec{b}| = |\vec{a} - \vec{b}|$. What is the angle between $\vec{a}$and $\vec{b}$?

a) 0° b) 90° c) 60° d) 180°

114. The maximum horizontal range of a projectile is 400 m. The maximum value of the height attained by it will be

a) 100 m b) 200 m c) 400 m d) 800 m

115. The second's hand of a watch has length 6 cm. Speed of end point and magnitude of difference of velocities at two perpendicular positions will be

a) 6.28 and 0 mm/s b) 8.88 and 4.44 mm/s c) 8.88 and 6.28 mm/s d) 6.28 and 8.88 mm/s

116. A cane filled with water is revolved in a vertical circle of radius 4 m and the water just does not fall down. The time period of revolution will be

a) 1 sec b) 10 sec c) 8 sec d) 4 sec

117. A heavy small sized sphere is suspended by a string of length l. The sphere is rotated uniformly in a horizontal circle with the string making an angle θ with the vertical. The time period of this conical pendulum is

a) $2\pi\sqrt{\frac{l \tan \theta}{g}}$ b) $2\pi\sqrt{l \sin \theta / g}$ c) $2\pi\sqrt{\frac{l}{g}}$ d) $2\pi\sqrt{\frac{l \cos \theta}{g}}$

118. The angular speed of seconds needle in a mechanical watch is

a) $\frac{\pi}{30}\ rad/s$ b) $2\pi\ rad/s$ c) $\pi\ rad/s$ d) $\frac{60}{\pi}\ rad/s$

119. The minimum speed for a particle at the lowest point of a vertical circle of radius r, to describe the circle is v. If the radius of the circle is reduced to one-fourth its value, the corresponding minimum speed will be

a) $v/4$ b) $v/2$ c) $2v$ d) $4v$

120. A particle of mass m is projected with a velocity v making an angle of 30° with the horizontal. The magnitude of angular momentum of the projectile about the point of projection when the particle is at its maximum height h is

a) $\frac{\sqrt{3}}{2}\frac{mv^2}{g}$ b) Zero c) $\frac{mv^3}{\sqrt{2g}}$ d) $\frac{\sqrt{3}}{16}\frac{mv^3}{g}$

121. A cyclist moves in such a way that he track 60° turn after 100 m. What is the displacement when to takes seventh turn?

a) 100 m b) 200 m c) $100\sqrt{3}$ m d) $100\sqrt{3}$ m

122. A body is moving in a circular path with acceleration a. If its velocity gets doubled, find the ratio of acceleration after and before the change

a) 1 : 4 b) $\frac{1}{4}$:2 c) 2 : 1 d) 4 : 1

123. A weightless thread can bear tension upto 37 N. A. stone of mass 500 g is tied to it and revolved in a circular path of radius 4 m in a vertical plane. If $g = 10\ ms^{-2}$, then the maximum angular velocity of the stone will be

a) 2 rad s^{-1} b) 4 rad s^{-1} c) 8 rad s^{-1} d) 16 rad s^{-1}

124. A ball is projected with velocity V_o at an angle of elevation 30° . Mark the correct statement

a) Kinetic energy will be zero at the highest point of the trajectory

b) Vertical component of momentum will be conserved

c) Horizontal component of momentum will be conserved

d) Gravitational potential energy will be minimum at the highest point of the trajectory

125. What is the unit vector along $\hat{i} + \hat{j}$?

a) $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ b) $\sqrt{2}(\hat{i}+\hat{j})$ c) $\hat{i}+\hat{j}$ d) $\hat{k}$

126. A child travelling in a train throws a ball outside with a speed V. According to a child who is standing on the ground, the speed of the ball is

a) Same as V b) Greater than V c) Less than V d) None of these

127. A weightless thread can bear tension upto3.7 kg wt. A stone of mass 500 gms is tied to it and revolved in a circular path of radius 4 m in a vertical plane. If $g = 10\ ms^{-2}$, then the maximum angular velocity of the stone will be

a) 4 $radians/sec$ b) 16 $radians/sec$ c) $\sqrt{21}$ $radians/sec$ d) 2 $radians/sec$

128. A car of mass 800 kg moves on a circular track of radius 40 m. If the coefficient of friction is 0.5, then maximum velocity with which the car can move is

a) 7 m/s b) 14 m/s c) 8 m/s d) 12 m/s

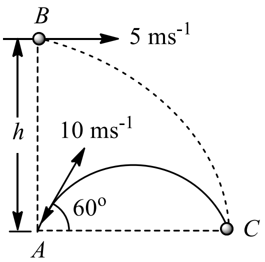
129. Which of the following statements is false for a particle moving in a circle with a constant angular speed?

a) The velocity vector is tangent to the circle
b) The acceleration vector is tangent to the circle
c) The acceleration vector point to the center of the circle
d) The velocity and acceleration vectors are perpendicular to each other

130. A particle moves in a circular orbit under the action of a central attractive force inversely proportional to the distance 'r'. The speed of the particle is

a) Proportional to r^2 b) Independent of r c) Proportional to r d) Proportional to $1/r$

131. A particle A is projected from the ground with an initial velocity of 10 ms^{-1}at an angle of 60° with horizontal. From what height h should an another particle B be projected horizontally with velocity 5ms^{-1} so that both the particles collide in ground at point C if both are projected simultaneously? ($\text{g} = 10\ \text{ms}^{-2}$)



a) 10 m b) 30 m c) 15 m d) 25 m

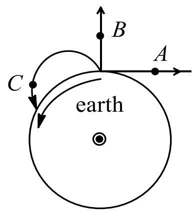
132. A body is moving with a certain velocity in a circular path. Now, the body reverses its direction, then

a) the magnitude of centripetal force remains same
b) the direction of centripetal force remains same
c) the direction of centripetal acceleration remains same
d) the of centripetal force does not change

133. An aeroplane is flying horizontally with a velocity of 216 kmh^{-1} and at a height of 1960 m. When it is vertically above a point A on the ground, a bomb is released from it. The bomb strikes the ground at point B. The distance AB is (ignoring air resistance)

a) 1200 m b) 0.33 km c) 3.33 km d) 33 km

134. A body 'A' moves with constant velocity on a straight line path tangential to the earth's surface. Another body 'B' is thrown vertically upwards, it goes to a height and falls back on earth. A third body 'C' is projected to an angle and follows a parabolic path as shown in figure



The bodies whose angular momentum relative to the center of the earth is conserved are

a) B only b) B and C c) A, B, C d) None of the above

135. A cart is moving horizontally along a straight line with constant speed 30 m/s. A projectile is to be fired from the moving cart in such a way that it will return to the cart after the cart has moved 80 m. At what speed (relative to the cart) must the projectile be fired (Take $g = 10\ m/s^2$)

a) $10\ m/s$ b) $10\sqrt{8}\ m/s$ c) $\frac{40}{3}\ m/s$ d) None of these

136. If $\vec{A}, \vec{B}$ and $\vec{C}$ are the unit vectors along the incident ray, reflected ray and outward normal to the reflecting surface, then

a) $\vec{B} = \vec{A} - \vec{C}$ b) $\vec{B} = \vec{A} + (\vec{A} \cdot \vec{C})\vec{C}$ c) $\vec{B} = 2\vec{A} - \vec{C}$ d) $\vec{B} = \vec{A} - 2(\vec{A} \cdot \vec{C})\vec{C}$

137. The string of a pendulum of length l is displaced through 90° from the vertical and released. Then the minimum strength of the string in order to withstand the tension as the pendulum passes through the mean position is

a) mg b) 6 mg c) 3 mg d) 5 mg

138. A particle reaches its highest point when it has covered exactly one half of its horizontal range. The corresponding point on the displacement time graph is characterised by

a) Negative slope and zero curvature
b) Zero slope and negative curvature
c) Zero slope and positive curvature
d) positive slope and zero curvature

139. If the vector $\vec{A} = 2\hat{\imath} + 4\hat{\jmath}$ and $\vec{B} = 5\hat{\imath} + p\hat{\jmath}$ are parallel to each other, the magnitude of $\vec{B}$ is

a) $5\sqrt{5}$ b) 10 c) 15 d) $2\sqrt{5}$

140. An arrow is shot into air. Its range is 200 m and its time of flight is 5s. If $g = 10m/s^2$, then the horizontal component of velocity of the arrow is

a) $12.5\ m/s$ b) $25\ m/s$ c) $31.25\ m/s$ d) $40\ m/s$

141. A stone of mass 2kg is tied to a string of length 0.5 m. If the breaking tension of the string is 900 N, then the maximum angular velocity, the stone can have in uniform circular motion is

a) 30 rads^{-1} b) 20 rads^{-1} c) 10 rads^{-1} d) 25 rads^{-1}

142. Four bodies P, Q, R and S are projected with equal velocities having angles of projection 15°, 30°, 45° and 60° with the horizontal respectively. The body having shortest range is

a) P b) Q c) R d) S

143. A plane surface is inclined making an angle θ with the horizontal. Form the bottom of this inclined plane, a bullet is fired with velocity v. The maximum possible range of the bullet on the inclined plane is

a) $\frac{v^2}{g}$ b) $\frac{v^2}{g(1+\sin\theta)}$ c) $\frac{v^2}{g(1-\sin\theta)}$ d) $\frac{v^2}{g(1+\sin\theta)^2}$

144. A body of mass 0.4 kg is whirled in a vertical circle making2 rev/sec. If the radius of the circle is 2 m, then tension in the string when the body is at the top of the circle, is

a) 41.56 N b) 89.86 N c) 109.86 N d) 115.86 N

145. For a particle in non-uniform accelerated circular motion

a) Velocity is radial and acceleration is transverse only
b) Velocity is transverse and acceleration is radial only
c) Velocity is radial and acceleration has both radial and transverse components
d) Velocity is transverse and acceleration has both radial and transverse components

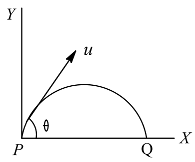
146. An aeroplane is flying horizontally with a constant velocity of 100 kmh^{-1} at a height of 1 km from the ground level. At $t = 0$, it starts dropping packets at constant time intervals of T_0. If R represents the separation between two consecutive points of impact on the ground, then for the first three packets, R_1/R_2 is

a) 1
b) >1
c) <1
d) Sufficient data is not given

147. The angle which the bicycle and its rider must make with the vertical when going round a curve of 7 m radius at 5 ms^{-1} is

a) 20° b) 15° c) 10° d) 5°

148. Average torque on a projectile of mass m, initial speed u and angles of projection θ, between initial and final position P and Q as shown in figure about the point of projection is



a) $mu^2 \sin\theta$ b) $mu^2 \cos\theta$ c) $\frac{1}{2} mu^2 \sin 2\theta$ d) $\frac{1}{2} mu^2 \cos 2\theta$

149. Two bullets are fired simultaneously, horizontally and with different speeds from the same place. Which bullet will hit the ground first?
a) The faster bullet
b) The slower bullet
c) Both will hit simultaneously
d) Depends on the masses

150. A stone of mass m is tied to a string and is moved in a vertical circle of radius r making n revolutions per $minute$. The total tension in the string when the stone is at its lowest point is
a) mg
b) $m(g + \pi n r^2)$
c) $m(g + \pi n r)$
d) $m\{g + (\pi^2 n^2\, r)/900\}$

151. A projectile is thrown with velocity v making an angle θ with the horizontal. It just crosses the tops of two poles, each of height h, after 1s and 3s respectively. The time of flight of the projectile is
a) 1 s b) 3 s c) 4 s d) 7.8 s

152. A coin placed on a rotating turn table just slips if it is placed at a distance of 8 cm from the centre. If angular velocity of the turn table is doubled, it will just slip at a distance of
a) 1 cm b) 2 cm c) 4 cm d) 8 cm

153. A bomb is dropped from an aeroplane moving horizontally at constant speed. When air resistance is taken into consideration, the bomb
a) Falls to earth exactly below the aeroplane
b) Fall to earth behind the aeroplane
c) Falls to earth ahead of the aeroplane
d) Flies with the aeroplane

154. One end of a string of length l is connected to a particle of mass m and the other to a small peg on a smooth horizontal table. If the particle moves in a circle with speed v, the net force on the particle (directed towards the centre) is
a) T b) $T - \frac{mv^2}{l}$ c) $T + \frac{mv^2}{l}$ d) Zero

155. Two bodies are projected from the same point with equal speeds in such directions that they both strike the same point on a plane whose inclination is β. If α be the angle of projection of the first body with the horizontal the ratio of their times of flight is
a) $\frac{\cos\alpha}{\sin(\alpha+\beta)}$ b) $\frac{\sin(\alpha+\beta)}{\cos\alpha}$ c) $\frac{\cos\alpha}{\sin(\alpha-\beta)}$ d) $\frac{\sin(\alpha-\beta)}{\cos\alpha}$

156. A car is circulating on the path of radius r and at any time its velocity is v and rate of increases of velocity is a. The resultant acceleration of the car will be
a) $\sqrt{\frac{v^2}{a^2} + r^2}$ b) $\sqrt{\frac{v^2}{r} + a}$ c) $\sqrt{\frac{v^4}{r^2} + a^2}$ d) $\left(\frac{v^2}{r} + a\right)$

157. Two bodies are projected from the same point with equal speeds in such directions that they both strike the same point on a plane whose inclination isβ. If ∝ be the angle of projection of the first body with the horizontal the ratio of their times of flight is
a) $\frac{\cos\propto}{\sin(\propto+\beta)}$ b) $\frac{\sin(\propto+\beta)}{\cos\propto}$ c) $\frac{\cos\propto}{\sin(\propto-\beta)}$ d) $\frac{\sin(\propto-\beta)}{\cos\propto}$

158. An athlete completes one round of a circular track of radius 10 m in 40 sec. The distance covered by him in 2 min 20 sec is
a) 70 m b) 140 m c) 110 m d) 220 m

159. A long horizontal rod has a bead which can slide along its length, and initially placed at a distance L from one end A of the rod. The rod is set in angular motion about A with constant angular acceleration α. If the coefficient of friction between the rod and the bead is μ, and gravity is neglected, then the time after which the bead starts slipping is

a) $\sqrt{\frac{\mu}{\alpha}}$ b) $\frac{\mu}{\sqrt{\alpha}}$ c) $\frac{1}{\sqrt{\mu\alpha}}$ d) Infinitesimal

160. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 s for every circular lap. The average velocity and average speed for each circular lap respectively is

a) 0,0 b) $0, 10\ \text{ms}^{-1}$ c) $10\ \text{ms}^{-1}, 10\ \text{ms}^{-1}$ d) $10\ \text{ms}^{-1}, 0$

161. A 500 kg crane takes a turn of radius 50 m with velocity of 36 km/hr. The centripetal force is

a) 1200 N b) 1000 N c) 750 N d) 250 N

162. The relation between the time of flight of a projectile T_f and the time to reach the maximum height t_m is

a) $T_f = 2t_m$ b) $T_f = t_m$ c) $T_f = \frac{t_m}{2}$ d) $T_f = \sqrt{2}(t_m)$

163. A particle P is moving in a circle of radius r with a uniform speed v. $C$is the centre of the circle and AB is the diameter. The angular velocity of P about A and C is in ratio

a) 1 : 1 b) 1 : 2 c) 2 : 1 d) 4 : 1

164. Two cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2 respectively. Their speeds are such that they make complete circles in the same time t. The ratio of their centripetal acceleration is

a) $m_1r_1 : m_2r_2$ b) $m_1 : m_2$ c) $r_1 : r_2$ d) 1 : 1

165. In a circus stuntman rides a motorbike in a circular track of radius R in the vertical plane. The minimum speed at highest point of track will be

a) $\sqrt{2gR}$ b) $2gR$ c) $\sqrt{3gR}$ d) $\sqrt{gR}$

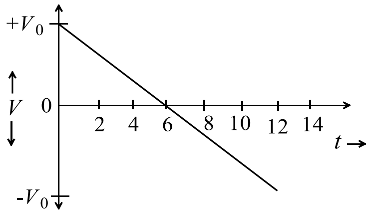
166. A particle describes a horizontal circle in a conical funnel whose inner surface is smooth with speed of 0.5 m/s. What is the height of the plane of circle from vertex of the funnel

a) 0.25 cm b) 2 cm c) 4 cm d) 2.5 cm

167. A road of 10 m width has radius of curvature 50 m. Its outer edge is raised above the inner edge by a distance of 1.5 m. The road is most suited for vehicles moving with velocity of

a) $8.5\ \text{ms}^{-1}$ b) $6.5\ \text{ms}^{-1}$ c) $5.5\ \text{ms}^{-1}$ d) None of these

168. Consider the given velocity-time graph



It represents the motion of

a) A projectile projected vertically upward, from a point

b) An electron in the hydrogen atom

c) A car with constant acceleration along a straight road

d) A bullet fired horizontally from the top of a tower

169. The maximum and minimum tensions in the string whirling in a circle of radius 2.5 m are in the ratio 5:3, then its velocity is

a) $\sqrt{98}\text{ms}^{-1}$ b) $7\ \text{ms}^{-1}$ c) $\sqrt{490}\text{ms}^{-1}$ d) $\sqrt{4.9}\text{ms}^{-1}$

170. A particle of mass m is circulating on a circle of radius r having angular momentum L, then the centripetal force will be

a) L^2/mr b) L^2m/r c) L^2/mr^3 d) L^2/mr^2

171. Two forces, each of magnitude F, have a resultant of the same magnitude F. The angle between the two forces is

a) 45° b) 120° c) 150° d) 180°

172. Given $\vec{c} = \vec{a} \times \vec{b}$. The angle which $\vec{a}$ makes with $\vec{c}$ is

a) 0° b) 45° c) 90° d) 180°

173. A helicopter is flying horizontally at an altitude of 2 km with a speed of $100\ \text{ms}^{-1}$. A packet is dropped from it. The horizontal distance between the point where the packet is dropped and the point where it hits the ground is ($g = 10\ \text{ms}^{-2}$)

a) 2 km	b) 0.2 km	c) 20 km	d) 4 km

174. A ball is projected with kinetic energy E at an angle of 45° to the horizontal. At the highest point during its flight, its kinetic energy will be

a) Zero	b) $E/_2$	c) $E/_{\sqrt{2}}$	d) E

175. A body is acted upon by a constant force directed towards a fixed point. The magnitude of the force varies inversely as the square of the distance from the fixed point. What is the nature of the path?

a) Straight line	b) Parabola	c) Circle	d) Hyperbola

176. A ball of mass 0.25 kg attached to the end of a string of length 1.96 m is moving in a horizontal circle. The string will break if the tension is more than 25N. What is the maximum speed with which the ball can be moved?

a) 14 $\mathrm{ms^{-1}}$	b) 3 $\mathrm{ms^{-1}}$	c) 3.92 $\mathrm{ms^{-1}}$	d) 5 $\mathrm{ms^{-1}}$

177. In a projectile motion, velocity at maximum height is

a) $\frac{u\cos\theta}{2}$	b) $u\cos\theta$	c) $\frac{u\sin\theta}{2}$	d) None of these

178. A particle of mass m is projected with a velocity v making an angle of 45° with the horizontal. The magnitude of angular momentum of projectile about the point of projection when the particle is at its maximum height h is

a) Zero	b) $\frac{mvh}{\sqrt{2}}$	c) $\frac{mvh^2}{\sqrt{2}}$	d) None of these

179. An object is moving in a circle of radius 100 m with a constant speed of 31.4 $\mathrm{ms^{-1}}$. What is its average speed for one complete revolution?

a) Zero	b) 31.4 $\mathrm{ms^{-1}}$	c) 3.14 $\mathrm{ms^{-1}}$	d) $\sqrt{2}\times 31.4\ \mathrm{ms^{-1}}$

180. A missile is fired for maximum range with an initial velocity of 20 m/s. If $g = 10\ m/s^2$, the range of the missile is

a) 20 m	b) 40 m	c) 50 m	d) 60 m

181. What is the angular velocity of earth?

a) $\frac{2\pi}{86400}$ rad $\mathrm{s^{-1}}$	b) $\frac{2\pi}{3600}$ rad $\mathrm{s^{-1}}$	c) $\frac{2\pi}{24}$ rad $\mathrm{s^{-1}}$l	d) $\frac{2\pi}{6400}$ rad $\mathrm{s^{-1}}$

182. A stone of mass 1 kg is tied at one end of string of length 1 m. It is whirled in a vertical circle at constant speed of 4 $\mathrm{ms^{-1}}$. The tension in the string is 6 N when the stone is at ($\mathrm{g = 10ms^{-2}}$)

a) Top of the circle	b) Bottom of the circle	c) Half way down	d) None of these

183. What should be the coefficient of friction between the tyres and the road, when a car travelling at 60 km $\mathrm{h^{-1}}$ makes a level turn of radius 40 m?

a) 0.5	b) 0.66	c) 0.71	d) 0.80

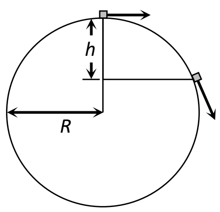
184. A body of mass 2 kg attached to a string is whirled in a vertical circle of radius 5 m. The minimum speed of the body at lowest point so that the cord does not slacken even at the highest point is

a) 15.65 $\mathrm{ms^{-1}}$	b) 6.75 $\mathrm{ms^{-1}}$	c) 20.87 $\mathrm{ms^{-1}}$	d) 45.83 $\mathrm{ms^{-1}}$

185. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 *seconds* for every circular loop. The average velocity and average speed for each circular loop respectively is

a) 10m/s, 10m/s	b) 10 m/s,0	c) 0, 0	d) 0,10 m/s

186. A particle originally at rest at the highest point of a smooth vertical circle is slightly displaced. It will leave the circle at a vertical distance h below the highest point such that



a) $h = R$	b) $h = \frac{R}{3}$	c) $h = \frac{R}{2}$	d) $h = \frac{2R}{3}$

187. The bob of a pendulum of mass m and length L is displaced, 90° from the vertical and gently released. In

order that the string may not break upon passing through the lowest point, its minimum strength must be

a) mg b) 2 mg c) 3 mg d) 4 mg

188. Projection of $\vec{P}$ on $\vec{Q}$is

a) $\vec{P}\cdot\hat{Q}$ b) $\hat{p}\cdot\vec{Q}$ c) $\vec{P}\times\hat{Q}$ d) $\vec{P}\times\vec{Q}$

189. When a body moves with a constant speed along a circle

a) No work is done on it

b) No acceleration is produced in the body

c) No force acts on the body

d) Its velocity remains constant

190. A cyclist moves in such a way that he track 60° turn after 100 m. What is the displacement when to takes seventh turn?

a) 100 m b) 200 m c) $100\sqrt{3}$ m d) $100\sqrt{3}$ m

191. A ball of mass 0.1 kg. Is whirled in a horizontal circle of radius 1 m. By means of a string at an initial speed of 10 $R.P.M$. Keeping the radius constant, the tension in the string is reduced to one quarter of its initial value. The new speed is

a) 5 $r.p.m.$ b) 10 $r.p.m.$ c) 20 $r.p.m.$ d) 14 $r.p.m.$

192. A fan is making 600 revolutions per $minute$. If after some time it makes 1200 revolutions per $minute$, then increase in its angular velocity is

a) $10\,\pi\ rad/sec$ b) $20\,\pi\ rad/sec$ c) $40\,\pi\ rad/sec$ d) $60\,\pi\ rad/sec$

193. A particle moves in a circular path with decreasing speed. Choose the correct statement.

a) Angular momentum remains constant

b) Acceleration **(a)** is towards the center

c) Particle moves in a spiral path with decreasing radius

d) The direction of angular momentum remains constant

194. At what point of a projectile motion acceleration and velocity and velocity are perpendicular to each other

a) At the point of projection

b) At the point of drop

c) At the topmost point

d) Any where in between the point of projection and topmost point

195. The centripetal acceleration of a particle of mass m moving with a velocity v in a circular orbit of radius r is

a) $v^2/\,r$ along the radius, towards the center

b) $v^2/\,r$ along the radius, away from the center

c) mv^2/r along the redius, away from the center

d) $mv^2/\,r$ along the radius, towards the center

196. Two projectiles A and Bthrown with speed in the ratio $1{:}\sqrt{2}$ acquired the same heights. If A is thrown at an angle of 45° with the horizontal, the angle of projection of Bwill be

a) 0° b) 60° c) 30° d) 45°

197. A boy playing on the roof of a 10 m high building throws a ball with a speed of 10 ms^{-1} at an angle of 30° with the horizontal. How far from the throwing point will the ball be at the height of 10 m from the ground?

$(g = 10\ ms^{-2}, \sin 30° = 1/2, \cos 30° = \sqrt{3}/2$

a) 5.20 m b) 4.33 m c) 2.60 m d) 8.66 m

198. A stone is tied to one end of a string and rotated in a horizontal circle with a uniform angular velocity. Let T be the tension in the string. If the length of the string is halved and its angular velocity is doubled, tension in the string will be

a) $T/4$ b) $T/2$ c) $2T$ d) $4T$

199. A stone thrown at an angle θ to the horizontal a projectile makes an angle $\pi/4$ with the horizontal, then its initial velocity and angle of projection are, respectively

a) $\frac{\sqrt{2h\sin\theta}}{g}$ b) $\frac{2\sqrt{2h\sin\theta}}{g}$ c) $2\sqrt{\frac{2h}{g}}$ d) $\sqrt{\frac{2h}{g}}$

200. A sphere is suspended by a thread of length l. What minimum horizontal velocity has to be imparted the

ball for it to reach the height of the suspension

a) gl b) $2gl$ c) $\sqrt{gl}$ d) $\sqrt{2gl}$

201. If retardation produced by air resistance of projectile is one-tenth of acceleration due to gravity, the time to reach maximum height

a) Decreases by 11 percent b) Increases by 11 percent
c) Decreases by 9 percent d) Increases by 9 percent

202. A particle is projected from the ground with an initial speed of v at an angle θ with horizontal. The average velocity of the particle between its point of projection and highest point of trajectory is

a) $\frac{v}{2}\sqrt{1+2\cos^2\theta}$ b) $\frac{v}{2}\sqrt{1+\cos^2\theta}$ c) $\frac{v}{2}\sqrt{1+3\cos^2\theta}$ d) $v\cos\theta$

203. There are two forces each of magnitude 10 units. One inclined at an angle of 30° and the other at an angle of 135° to the positive direction of x —axis. The x and y components of the resultant are respectively.

a) $1.59\hat{\imath}$ and $12.07\hat{\jmath}$ b) $10\hat{\imath}$ and $10\hat{\jmath}$ c) $1.59\hat{\imath}$ d) $15.9\hat{\imath}$ and $12.07\hat{\jmath}$

204. A particle is moving in a circle of radius R in such a way that at any instant the normal and tangential components of its acceleration are equal. If its speed at $t=0$ is v_0, the time taken to complete the first revolution is

a) $\frac{R}{v_0}$ b) $\frac{R}{v_0}(1-e^{-2\pi})$ c) $\frac{R}{v_0}e^{-2\pi}$ d) $\frac{2\pi R}{v_0}$

205. The tension in the string revolving in a vertical circle with a mass m at the end which is the lowest position

a) $\frac{mv^2}{r}$ b) $\frac{mv^2}{r}-mg$ c) $\frac{mv^2}{r}+mg$ d) mg

206. The ratio of the angular speed of minutes hand and hour hand of a watch is

a) 6 : 1 b) 12 : 1 c) 1 : 6 d) 1 : 12

207. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 s for every circular lap. The average velocity and average speed for each circular lap is

a) 0, 0 b) $0, 10 ms^{-1}$ c) $10\ ms^{-1}, 10 ms^{-1}$ d) $10\ ms^{-1}, 0$

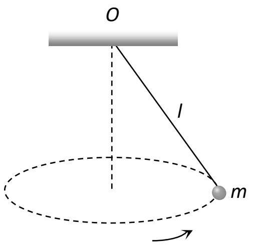
208. An aeroplane moving horizontally with a speed of 720 km/h drops a food pocket, while flying at a height of 396.9 m. The time taken by a food pocket to reach the ground and its horizontal range is (Take $g = 9.8\ m/sec^2$)

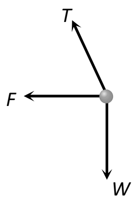
a) 3 sec and 2000 m b) 5 sec and 500 m c) 8 sec and 1500 m d) 9 sec and 1800 m

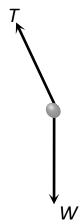
209. A cyclist turns around a curve at 15 miles/hour. If the turns at double the speed, the tendency to overturn is

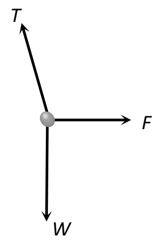
a) Doubled b) Quadrupled c) Halved d) Unchanged

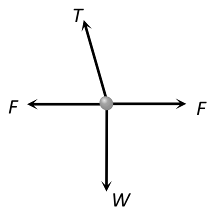
210. A point mass m is suspended from a light thread of length l, fixed at$O$, is whirled in a horizontal circle at constant speed as shown. From your point of view, stationary with respect to the mass, the forces on the mass are



a) 

b) 

c) 

d) 

211. Two tall buildings are 40 m apart. With what speed must a ball be thrown horizontally from a window 145 m above the ground in one building, so that it will enter a window 22.5 m from the ground in the other?

a) 5 ms^{-1} b) 8 ms^{-1} c) 10 ms^{-1} d) 16 ms^{-1}

212. A wheel rotates with a constant angular velocity of 300 rpm. The angle through which the wheel rotates in one second is

a) π rad b) 5 π rad c) 10 π rad d) 20 π rad

213. A tube of length$L$ is filled completely with an incompressible liquid of mass $M$and closed at both the ends. The tube is then rotated in a horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is

a) $\frac{ML\omega^2}{2}$ b) $ML\omega^2$ c) $\frac{ML\omega^2}{4}$ d) $\frac{ML^2\omega^2}{2}$

214. A stone is thrown with a velocity v making an angle θ with the horizontal. At some instant, its velocity V is perpendicular to the initial velocity v. Then V is

a) $v \sin\theta$ b) $v \cos\theta$ c) $v \tan\theta$ d) $v \cot\theta$

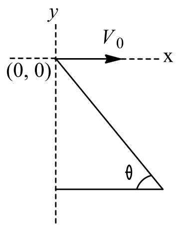
215. If the length of the second's hand in a stop-clock is 3 cm, the angular velocity and linear velocity of the tip is

a) 0.2047 $rads^{-1}$, 0.0314 ms^{-1}
b) 0.2547 $rads^{-1}$, 0.0314 ms^{-1}
c) 0.1472 $rads^{-1}$, 0.06314 ms^{-1}
d) 0.1047 $rads^{-1}$, 0.00314 ms^{-1}

216. A cylindrical vessel partially filled with water is rotated about its vertical central axis. It's surface will

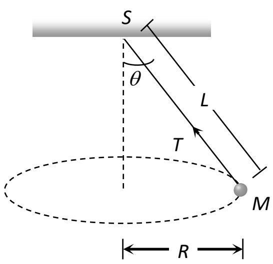
a) Rise equally b) Rise from the sides c) Rise from the middle d) Lowered quality

217. A man standing on a hill top projects a stone horizontally with speed v_0 as shown in figure. Taking the coordinate system as given in the figure. The coordinates of the point where the stone will hit the hill surface



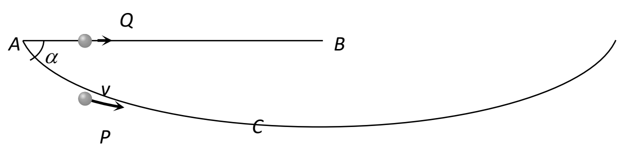
a) $\left(\frac{2v_0^2\tan\theta}{g}, \frac{-2v_0^2\tan^2\theta}{g}\right)$
b) $\left(\frac{2v_0^2}{g}, \frac{2v_0^2\tan^2\theta}{g}\right)$
c) $\left(\frac{2v_0^2\tan\theta}{g}, \frac{2v_0^2}{g}\right)$
d) $\left(\frac{2v_0^2\tan^2\theta}{g}, \frac{2v_0^2\tan\theta}{g}\right)$

218. A string of length L is fixed at one end and carries a mass M at the other end. The string makes $2/\pi$ revolutions per *second* around the vertical axis through the fixed end as shown in figure , then tension in the string is



a) ML b) 2 ML c) 4 ML d) 16 ML

219. A particle P is sliding down a frictionless hemispherical bowl. It passes the point Aat $t = 0$. At this instant of time, the horizontal component of its velocity v. A bead Q of the same mass as P is ejected from A to $t = 0$ along the horizontal string AB (see figure) with the speed v. Friction between the bead and the string may be neglected. Let t_p and t_Q be the respective time taken by P and Q to reach the point B. Then



a) $t_p < t_Q$ b) $t_p = t_Q$ c) $t_p > t_Q$ d) All of these

220. The string of a pendulum of length l is displaced through 90° from the vertical and released. Then the minimum strength of the string in order to withstand the tension as the pendulum passes through the mean position is

a) mg b) 6 mg c) 3 mg d) 5 mg

221. Velocity vector and acceleration vector in a uniform circular motion are related as

a) Both in the same direction b) Perpendicular to each other

c) Both in opposite direction d) No related to each other

222. Two projectiles thrown from the same point at angles 60° and 30° with the horizontal attain the same height. The ratio of their initial velocities is

a) 1 b) 2 c) $\sqrt{3}$ d) $\frac{1}{\sqrt{3}}$

223. An aeroplane flying at a velocity of 900kmh^{-1} loops the loop. If the maximum force pressing the pilot against the seat is five times its weight, the loop radius should be

a) 1594 m b) 1402 m c) 1315 m d) 1167 m

224. If KE of the particle of mass m performing UCM in a circle of radius r is E. Find the acceleration of the particale

a) $\frac{2E}{mr}$ b) $\left(\frac{2E}{mr}\right)^2$ c) 2 Emr d) $\frac{4E}{mr}$

225. A particle of mass 100 g tied to a string is rotated along circle of radius 0.5 m. The breaking tension of string is 10 N. The maximum speed with which particle can rotated without breaking the string is

a) 10 ms^{-2} b) 9.8 ms^{-2} c) 7.7 ms^{-2} d) 7.07 ms^{-2}

226. A boy is hanging from a horizontal branch of a tree. The tension in the arms will be maximum when the angle between the arms is

a) 0° b) 60° c) 90° d) 120°

227. A particle P is at the origin starts with velocity $\vec{\mathbf{v}} = (2\hat{\mathbf{i}} - 4\hat{\mathbf{j}})$ms^{-1} with constant acceleration $(3\hat{\mathbf{i}} - 5\hat{\mathbf{j}})$ms^{-2}. After travelling for 2 s, its distance from the origin is

a) 10 m b) 10.2 m c) 9.8 m d) 11.7 m

228. An object of mass 5 kg is whirled round in a vertical circle of radius 2 m with a constant speed of 6 ms^{-1}. The maximum tension in the string is

a) 152 N b) 139 N c) 121 N d) 103 N

229. For a projectile the ratio of maximum height reached to the square of time of flight is (g = 10 ms^{-1})

a) 5 : 1 b) 5 : 2 c) 5 : 4 d) 1 : 1

230. If the body is moving in a circle of radius r with a constant speed v, its angular velocity is

a) v^2/r b) vr c) v/r d) r/v

231. One end of a string of length l is connected to a particle of mass m and other to a small peg on a smooth horizontal table. If the particle moves in a circle with speed v, the net force on the particle (directed towards the centre) is

a) T b) $T - \frac{mv^2}{l}$ c) $T + \frac{mv^2}{l}$ d) zero

232. A body of mass m is projected at an angle of 45° with the horizontal. If air resistance is negligible, then total change in momentum when it strikes the ground is

a) $2mv$ b) $\sqrt{2}\, mv$ c) mv d) $mv/\sqrt{2}$

233. At the point of a projectile motion, acceleration and velocity are perpendicular to each other?

a) At the point of projection

b) At the point of drop

c) At the top most point

d) Anywhere in between the point of projection and two most point

234. A ball rolls of the top of stair-way with a horizontal velocity of magnitude 1.8 ms^{-1}. The steps are 0.20 m high and 0.20 m wide. Which step will the ball hit first?

a) First b) Second c) Third d) Fourth

235. A particle moves along a circle of radius $\left(\frac{20}{\pi}\right)$ m with constant tangential acceleration. If the velocity of the particle is 80 ms^{-1}, at the end of seconds revolution after motion has begun, the tangential acceleration is

a) 40 ms^{-2} b) 640 π ms^{-2} c) 1609 π ms^{-2} d) 40 π ms^{-2}

236. Tom and Dick are running forward with the same speed. They are throwing a rubber ball to each other at a constant speed v as seen by the thrower. According to Sam who is standing on the ground the speed of the ball is

a) Same as v b) Greater than v c) Less than v d) None of these

237. Two paper screens A and B are separated by a distance of 200 m. A bullet pierces A and then B. The hole in B is 40 cm below the hole in A. If the bullet is travelling horizontally at the time of hitting A, then the velocity of the bullet at A is

a) 200 ms^{-1} b) 400 ms^{-1} c) 600 ms^{-1} d) 700 ms^{-1}

238. A 2 kg stone tied at the end of a string 1 m long is whirled along a vertical circle at a constant speed of 4 ms^{-1}. The tension in the string has a value of 52 N when the stone is

a) At the top of the circle b) Half way down
c) At the bottom of the circle d) None of the above

239. A stone of mass m is tied to a string of length l and rotated in a circle with a constant speed v. If the string is released, the stone flies

a) Radially outwards b) Radially inwards
c) Tangentially outwards d) With an acceleration mv^2/l

240. If a cycle wheel of radius 4 m completes one revolution in two seconds. Then acceleration of a point on the cycle wheel will be

a) $\pi^2 m/s^2$ b) $2\pi^2 m/s^2$ c) $4\pi^2 m/s^2$ d) $8\pi m/s^2$

241. A projectile is thrown at angle βwith vertical. It reaches a maximum height H. The time taken to reach the highest point of its path is

a) $\sqrt{\frac{H}{g}}$ b) $\sqrt{\frac{2H}{g}}$ c) $\sqrt{\frac{H}{2g}}$ d) $\sqrt{\frac{2H}{g\cos\beta}}$

242. The radius vector and linear momentum are respectively given by vector $2\hat{i}+2\hat{j}+\hat{k}$ and $2\hat{i}-2\hat{j}+\hat{k}$. Their angular momentum is

a) $2\hat{i}-4\hat{j}$ b) $4\hat{i}-8\hat{k}$ c) $2\hat{i}-4\hat{j}+2\hat{k}$ d) $4\hat{i}-8\hat{j}$

243. A fighter plane is moving in a vertical circle of radius $'r'$. Its minimum velocity at the highest point of the circle will be

a) $\sqrt{3\,g\,r}$ b) $\sqrt{2\,g\,r}$ c) $\sqrt{g\,r}$ d) $\sqrt{g\,r/2}$

244. A particle moves in a circle of radius 30cm. Its liner speed is given by $v=2t$, where t is in second and $v$in ms^{-1}. Find out its, radial and tangential acceleration at $t=3$s, respectively,

a) 220 ms^{-2}, 50 ms^{-2} b) 100 ms^{-2}, 5 ms^{-2} c) 120 ms^{-2}, 2 ms^{-2} d) 110 ms^{-2}, 10 ms^{-2}

245. When a simple pendulum is rotated in a vertical plane with constant angular velocity, centripetal force is

a) Maximum at highest point b) Maximum at lowest point
c) Same at all lower point d) Zero

246. A particle is projected with velocity V_0 along x-axis. The deceleration on the particle is proportional to the square of the distance from the origin i.e. $a=\alpha x^2$, the distance at which the particle stops is

a) $\sqrt{\frac{3V_0}{2\alpha}}$ b) $\left(\frac{3V_0}{2\alpha}\right)^{\frac{1}{3}}$ c) $\sqrt{\frac{2V_0^2}{3\alpha}}$ d) $\left(\frac{3V_0^2}{2\alpha}\right)^{\frac{1}{3}}$

247. A particle leaves the origin with an initial velocity $\vec{\mathbf{v}}=(3.00\hat{\mathbf{i}})ms^{-1}$ and a constant acceleration $\vec{\mathbf{a}}=(-1.00\hat{\mathbf{i}}-0.50\hat{\mathbf{j}})\ ms^{-2}$. When the particle reaches it maximum x-coordinate, what is its y-component a velocity?

a) -2.0 ms^{-1} b) -1.0 ms^{-1} c) -1.5 ms^{-1} d) 1.0 ms^{-1}

248. What is the angular velocity of earth

a) $\frac{2\pi}{86400}\ rad/sec$ b) $\frac{2\pi}{3600}\ rad/sec$ c) $\frac{2\pi}{24}\ rad/sec$ d) $\frac{2\pi}{6400}\ rad/sec$

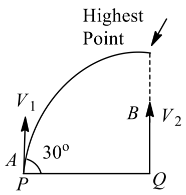
249. The area o the parallelogram represented by the vectors. $\vec{A} = 4\hat{i} + 3\hat{j}$ and $\vec{B} = 2\hat{i} + 4\hat{j}$ is

a) 14 units b) 7.5 units c) 10 units d) 5 units

250. A cricket ball is hit at 30° with the horizontal with kinetric energy E_k. What is the kinetic energy at the highest point?

a) $E_k/2$ b) $3E_k/4$ c) $E_k/4$ d) Zero

251. A projectile A is thrown at an angle of 30° to the horizontal from point P. At the same time, another projectile B is thrown with velocity v^2 upwards from the point Q vertically below the highest point. For B to collide with A, $\frac{v_2}{v_1}$ should be



a) 1 b) 2 c) $\frac{1}{2}$ d) 4

252. A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time as $a_c = k^2rt^4$, where k is a constant. The power delivered to the particle by the forces acting on its is

a) Zero b) $mk^2r^2t^2$ c) $\frac{1}{3}mk^2r^2t^2$ d) $2mk^2r^2t^3$

253. The angle of projection at which the horizontal range and maximum height of projectile are equal is

a) 45° b) $\theta = \tan^{-1}(0.25)$

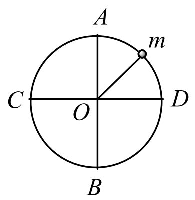
c) $\theta = \tan^{-1} 4$or ($\theta = 76°$) d) 60°

254. For motion in a plane with constant acceleration $\vec{a}$, initial velocity$\vec{v}_0$ and final velocity $\vec{v}$ after time t, we have

a) $\vec{v}.(\vec{v} - \vec{a}t) = \vec{v}_0.(\vec{v}_0 + \vec{a}t)$ b) $\vec{v}.\vec{v}_0 = at^2$

c) $\vec{v}.\vec{v}_0 = \vec{v}.\vec{v}_0 t$ d) $\vec{v}_0.\vec{v}_0 = \vec{a}.\vec{v}_0 t$

255. A small sphere is attached to a cord and rotates in a vertical circle about a point O. If the average speed of the sphere is increased, the cord is most likely to break at the orientation when the mass is at



a) Bottom point B b) Top point A c) The point D d) The point C

256. A projectile is thrown in the upward direction making an angle of 60° with the horizontal direction with a velocity of147ms^{-1}. Then the time after which its inclination with the horizontal is 45°, is

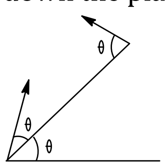
a) 15 s b) 10.98 s c) 5.49 s d) 2.745 s

257. If the length of the second's hand in a stop clock is 3 cm the angular velocity and linear velocity of the tip is

a) 0.2047 $rad/sec.$, 0.0314 m/sec b) 0.2547 $rad/sec.$, 0.314 m/sec

c) 0.1472 $rad/sec.$, 0.06314 m/sec d) 0.1047 $rad/sec.$, 0.00314 m/sec

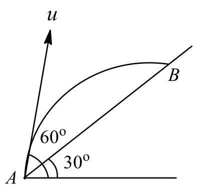
258. From an inclined plane two particles are projected with same speed at same angle θ, one up and other down the plane as shown in figure. Which of the following statements (s) is/are correct?



a) The time of flight of each particle is the same.

b) The particles will collide the plane with same speed
c) Both the particles strike the plane perpendicularly
d) The particles will collide in mid air if projected simultaneously and time of flight of each particle is less than the time of collision

259. The time taken by the projectile to reach from A to B is t, then the distance AB is equal to



a) $2\,ut$ b) $\sqrt{3}\,ut$ c) $\frac{\sqrt{3}}{2}ut$ d) $\frac{ut}{\sqrt{3}}$

260. An arrow is projected into air. Its time of flight is 8 s and range 200 m. What is the maximum height reached by it? (Take $g = 10\ \text{ms}^{-2}$)
a) 31.25 m b) 24.5 m c) 18.25 m d) 46.75 m

261. A particle of mass $= 5$ is moving with a uniform speed $v = 3\sqrt{2}$ in the XOY plane along the line $Y = X + 4$. The magnitude of the angular momentum of the particle about the origin is
a) 60 units b) $40\sqrt{2}$ units c) 7.5 units d) zero

262. A shell is fired from a cannon with a velocity v at angle θwith horizontal. At the highest point, it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon. The speed of the other piece just after explosion is
a) $3\,v\cos\theta$ b) $2\,v\cos\theta$ c) $\frac{3}{2}v\cos\theta$ d) $\frac{\sqrt{3}}{2}v\cos\theta$

263. Given $\vec{A} = \hat{i} + 2\hat{j} - 3\hat{k}$. When a vector $\vec{B}$ is added to $\vec{A}$, We get a unit vector along X=axis. Then, $\vec{B}$ is
a) $-2\hat{j} + 3\hat{k}$ b) $-\hat{i} - 2\hat{j}$ c) $-\hat{i} + 3\hat{k}$ d) $2\hat{j} - 3\hat{k}$

264. A hollow sphere has radius 6.4 m. Minimum velocity required by a motor cyclist at bottom to complete the circle will be
a) 17.7 m/s b) 10.2 m/s c) 12.4 m/s d) 16.0 m/s

265. $\vec{A} = 3\hat{i} - \hat{j} + 7\hat{k}$ and $\vec{B} = 5\hat{i} - \hat{j} + 9\hat{k}$ the direction cosine m of the vector $\vec{A} + \vec{B}$ is
a) Zero b) $\frac{3}{\sqrt{31}}$ c) $\frac{9}{\sqrt{107}}$ d) 5

266. A car sometimes overturns while taking a turn. When it overturns, it is
a) The inner wheel which leaves the ground first
b) The outer wheel which leaves the ground first
c) Both the wheels leave the ground simultaneously
d) Either wheel leaves the ground first

267. A car of mass 1000 kg moves on a circular track of radius 20 m. If the coefficient of friction is 0.64, then the maximum velocity with which the car can move is
a) $22.4\ \text{ms}^{-1}$ b) $5.6\ \text{ms}^{-1}$ c) $11.2\ \text{ms}^{-1}$ d) None of these

268. A projectile is thrown with a speed u at an angle θ to the horizontal. The radius of curvature of its trajectory when the velocity vector of the projectile makes an angle α with the horizontal is
a) $\frac{u^2\cos^2\alpha}{g\cos^2\theta}$ b) $\frac{2u^2\cos^2\alpha}{g\cos^2\theta}$ c) $\frac{u^2\cos^2\theta}{g\cos^3\alpha}$ d) $\frac{u^2\cos^2\theta}{g\cos^2\alpha}$

269. A stone of mass 1 kg is tied to a string 4 m long and is rotated at constant speed of $40\ \text{ms}^{-1}$ in a vertical circle. The ratio of the tension at the top and the bottom is
a) 11 : 12 b) 39 : 41 c) 41 : 39 d) 12 : 11

270. The magnitudes of the two vectors $\vec{a}$ and $\vec{b}$ are a and b respectively. The vector product of $\vec{a}$ and $\vec{b}$ cannot be
a) equal to zero b) less than ab c) equal to ab d) greater than ab

271. A projectile is thrown at angle β with vertical. It reaches a maximum height H. The time taken to reach the

highest point of its path is

a) $\sqrt{\frac{H}{g}}$ b) $\sqrt{\frac{2H}{g}}$ c) $\sqrt{\frac{H}{2g}}$ d) $\sqrt{\frac{H}{g\cos\beta}}$

272. A boy on a cycle pedals around a circle of 20 $metres$ radius at a speed of 20 $metres/sec$. The combined mass of the boy and the cycle is 90 kg.The angle that the cycle makes with the vertical so that it may not fall is ($g = 9.8\ m/sec^2$)

a) 60.25° b) 63.90° c) 26.12° d) 30.00°

273. A stone is thrown at an angle θ to the horizontal reaches a maximum height H. Then the time of flight of stone will be

a) $\sqrt{\frac{2H}{g}}$ b) $2\sqrt{\frac{2H}{g}}$ c) $\frac{2\sqrt{2H\sin\theta}}{g}$ d) $\frac{\sqrt{2H\sin\theta}}{g}$

274. A body crosses the topmost point of a vertical circle with critical speed. Its centripetal acceleration, when the string is horizontal will be

a) 6 g b) 3 g c) 2 g d) g

275. A particle revolves around a circular path. The acceleration of the particle is

a) Along the circumference of the circle b) Along the tangent
c) Along the radius d) Zero

276. If a particle covers half the circle of radius R with constant speed then

a) Change in momentum is mvr b) Change in $K.E.$ is $1/2\ mv^2$
c) Change in $K.E.$ is mv^2 d) Change in $K.E.$ is zero

277. If $\vec{A} + \vec{B} = \vec{C}$ and $A = \sqrt{3}, B = \sqrt{3}$ and $C = 3$, then the angle between $\vec{A}$ and $\vec{B}$ is

a) 0° b) 30° c) 60° d) 90°

278. The angle turned by a body undergoing circular motion depends on time as $\theta = \theta_0 + \theta_1 t + \theta_2 t^2$. Then the angular acceleration of the body is

a) θ_1 b) θ_2 c) $2\theta_1$ d) $2\theta_2$

279. Given $\vec{A} = 4\hat{\imath} + 6\hat{\jmath}$and $\vec{B} = 2\hat{\imath} + 3\hat{\jmath}$. Which of the following is correct?

a) $\vec{A} \times \vec{B} = \vec{0}$ b) $\vec{A} \cdot \vec{B} = 24$
c) $\frac{|\vec{A}|}{|\vec{B}|} = \frac{1}{2}$ d) $\vec{A}$ and $\vec{B}$ are anti-parallel

280. A bullet is fired with a velocity u making an angle of 60° with the horizontal plane. The horizontal component of the velocity of the bullet when it reaches the maximum height is

a) u b) 0 c) $\frac{\sqrt{3}u}{2}$ d) $u/2$

281. A cart is moving horizontally along a straight line with constant speed30 $\mathrm{ms^{-1}}$. A projectile is to be fired from the moving cart in such a way that it will return to the cart has moved 80 m. At what speed (relative to the cart) must the projectile be fired? (Take $g = 10\ \mathrm{ms^{-2}}$)

a) 10 $\mathrm{ms^{-1}}$ b) $10\sqrt{8}\mathrm{ms^{-1}}$ c) $\frac{40}{3}\mathrm{ms^{-1}}$ d) None of the above

282. A car is moving with high velocity when it has a turn. A force acts on it outwardly because of

a) Centripetal force b) Centrifugal force c) Gravitational force d) All the above

283. The area of parallelogram formed from the vectors $\vec{A} = \hat{\imath} - 2\hat{\jmath} + 3\hat{k}$ and $\vec{B} = 3\hat{\imath} - 2\hat{\jmath} + \hat{k}$ as adjacent sides is

a) $8\sqrt{3}$ units b) 64 units c) 32 units d) $4\sqrt{6}$ units

284. The maximum velocity (in ms^{-1}) with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is

a) 60 b) 30 c) 15 d) 25

285. The maximum and minimum tension in the string whirling in a circle of radius 2.5 m with constant velocity are in the ratio 5: 3 the velocity is

a) $\sqrt{98}\ m/s$ b) 7 m/s c) $\sqrt{490}\ m/s$ d) $\sqrt{4.9}$

286. A body is projected from the earth at angle 30° with the horizontal with some initial velocity. If its range is 20 m, the maximum height reached by its is (in metre)

a) $5\sqrt{3}$ b) $\frac{5}{\sqrt{3}}$ c) $\frac{10}{\sqrt{3}}$ d) $10\sqrt{3}$

287. Neglecting the air resistance, the time of flight of a projectile is determined by

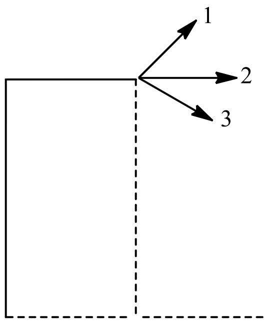
a) $U_{vertical}$ b) $U_{horizontal}$

c) $U = U_{vertical}^2 + U_{horizontal}^2$ d) $U = U\left(U_{vertical}^2 + U_{horizontal}^2\right)^{1/2}$

288. If the magnitudes of scalar and vector products of two vectors and are 6 and $6\sqrt{3}$ respectively, then the angle between two vectors is

a) 15° b) 30° c) 60° d) 75°

289. Three balls are dropped from the top of a building with equal speed at different angles. When the balls strike ground their velocities are v_1, v_2 and v_3 respectively, then



a) $v_1 > v_2 > v_3$ b) $v_3 > v_2 > v_1$ c) $v_1 = v_2 = v_3$ d) $v_1 < v_2 < v_3$

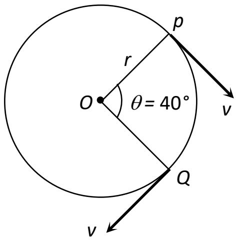
290. An object is projected at an angle of 45° with the horizontal. The horizontal range and maximum height reached will be in the ratio

a) 1:2 b) 2:1 c) 1:4 d) 4:1

291. A coin, placed on a rotating turn-table slips, when it is placed at a distance of 9 cm from the centre. If the angular velocity of the turn-table is tripled, it will just slip, if its distance from the centre is

a) 27 cm b) 9 cm c) 3 cm d) 1 cm

292. A particle is moving on a circular path of radius r with uniform velocity v. The change in velocity when the particle moves from P to Q is ($\angle POQ = 40°$)



a) $2v \cos 40°$ b) $2v \sin 40°$ c) $2v \sin 20°$ d) $2v \cos 20°$

293. A coin is placed on a gramophone record rotating at a speed of 45 rpm. It flies away when the rotational speed is 50 rpm. If two such coins are placed over the other on the same record, both of them will fly away when rotational speed is

a) 100 rpm b) 25 rpm c) 12.5 rpm d) 50 rpm

294. A body is whirled in a horizontal circle of radius 20 cm. It has angular velocity of 10 rad/s. What is its linear velocity at any point on circular path

a) 10 m/s b) 2 m/s c) 20 m/s d) $\sqrt{2}\, m/s$

295. For a given velocity, a projectile has the same range R for two angles of projection if t_1 and t_2 are the times of flight in the two cases then

a) $t_1 t_2 \propto R^2$ b) $t_1 t_2 \propto R$ c) $t_1 t_2 \propto \frac{1}{R}$ d) $t_1 t_2 \propto \frac{1}{R^2}$

296. A projectile is fired with a velocity v at right angle to the slope which is inclined at an angle θ with the horizontal. What is the time of flight?

a) $\frac{2v^2}{g}\tan\theta$ b) $\frac{v^2}{g}\tan\theta$ c) $\frac{2v^2}{g}\sec\theta$ d) $\frac{2v^2}{g}\tan\theta\sec\theta$

297. The horizontal range of a projectile is $4\sqrt{3}$ times its maximum height. Its angle of projection will be

a) 45° b) 60° c) 90° d) 30°

298. A boy whirl is a stone in a horizontal circle of radius 1.5 m and at height 2.0 m above level ground. The string breaks and the stone flies off tangentially and strikes the ground after traveling a horizontal distance of 10 m. What is the magnitude of the centripetal acceleration of the stone while in circular motion?

a) 163 ms^{-2} b) 64 ms^{-2} c) 15.63 ms^{-2} d) 125 ms^{-2}

299. Two vectors $\vec{A}$ and $\vec{B}$ are inclined to each other at an angle θ. Which of the following is the unit vector perpendicular to both $\vec{A}$and $\vec{B}$?

a) $\frac{\vec{A}\times\vec{B}}{\vec{A}\cdot\vec{B}}$ b) $\frac{\hat{A}\cdot\hat{B}}{\sin\theta}$ c) $\frac{\vec{A}\times\vec{B}}{AB\sin\theta}$ d) $\frac{\hat{A}\times\hat{B}}{AB\cos\theta}$

300. It was calculated that a shell when fired from a gun with a certain velocity and at an angle of elevation $\frac{5\pi}{36}$ rad should strike a given target. In actual practice, it was found that a hill just prevented the trajectory. At what angle of elevation should the gun be to hit the target?

a) $\frac{5\pi}{36}$rad b) $\frac{11\pi}{36}$rad c) $\frac{7\pi}{36}$rad d) $\frac{13\pi}{36}$rad

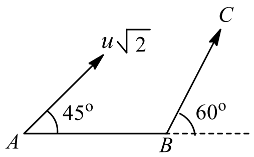
301. A particle does uniform circular motion in a horizontal plane. The radius of the circle is 20 cm. The centripetal force acting on the particle is 10 N. It's kinetic energy is

a) 0.1 J b) 0.2 J c) 2.0 J d) 1.0 J

302. The condition of apparent weightlessness can be created momentarily when a plane flies over the top of a vertical circle. At a speed of 900 kmh^{-1}, the radius of the vertical circle that the pilot must use is

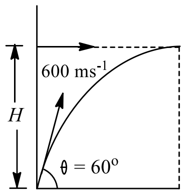
a) 10.6 km b) 8.5 kg c) 6.4 km d) 4.0 km

303. A particle is projected from a point A with velocity $u\sqrt{2}$ at an angle of 45° with horizontal as shown in figure. It strikes the plane BC at right angles. The velocity of the particle at the time of collision is



a) $\frac{\sqrt{3}u}{2}$ b) $\frac{u}{2}$ c) $\frac{2u}{\sqrt{3}}$ d) u

304. A fighter plane enters inside the enemy territory, at time $t = 0$ with velocity $v_0 = 250$ ms^{-1} and moves horizontally with constant acceleration $a = 20ms^{-2}$ (see figure). An enemy tank at the border, spot the plane and fire shots at an angle $\theta = 60°$ with the horizontal and with velocity $u = 600$ ms^{-1}. At what altitude H of the plane it can be hit by the shot?



a) $1500\sqrt{3}$m b) 125 m c) 1400 m d) 2473 m

305. At the height 80 m, an aeroplane is moving with 150 m/s. A bomb is dropped from it so as to hit a target. At what distance from the target should be bomb be dropped (Given $g = 10$ m/s^2)

a) 605.3 m b) 600 m c) 80 m d) 230 m

306. An object moves at a constant speed along a circular path in a horizontal XY plane, with the centre at the origin. When the object is at $x = -2m$, its velocity is $-(4m/s)\hat{j}$. What is the object's acceleration when it is $y = 2m$

a) $-(8m/s^2)\hat{j}$ b) $-(8m/s^2)\hat{i}$ c) $-(4m/s^2)\hat{j}$ d) $(4m/s^2)\hat{i}$

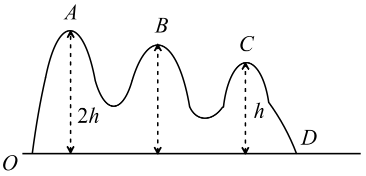
307. The momentum of a particle is $\vec{P}$=2cost$\hat{i}$ + 2sint$\hat{j}$. What is the angle between the force $\vec{F}$ acting on the particle and the momentum $\vec{P}$

a) 65° b) 90° c) 150° d) 180°

308. If the angle of projection of a projectile is 30°, then how many times the horizontal range is larger than the maximum height?

a) 2 b) 3 c) $3\sqrt{4}$ d) $4\sqrt{3}$

309. A small roller coaster starts at point A with a speed u on a curved track as shown in figure



The friction between the roller coaster and the track is negligible and it always remains in contact with the track. The speed of the roller coaster at point D on the track will be

a) $(u^2+gh)^{\frac{1}{2}}$ b) $(u^2+2gh)^{\frac{1}{2}}$ c) $(u^2+4gh)^{\frac{1}{2}}$ d) u

310. The vectors $2\hat{i}+3\hat{j}-2\hat{k}$, $5\hat{i}+a\hat{j}+\hat{k}$ and $-\hat{i}+2\hat{j}+3\hat{k}$ are coplanar when a is

a) −9 b) 9 c) −18 d) 18

311. Centripetal acceleration is

a) A constant vector b) A constant scalar

c) A magnitude changing vector d) Not a constant vector

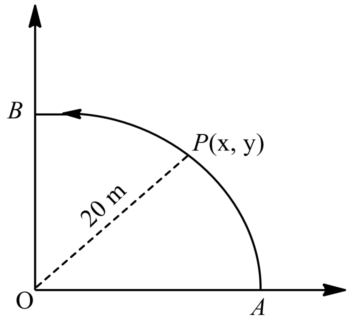
312. The trajectory of a projectile in vertical plane in $y=ax-bx^2$, where a and b are constant and x and y are respectively horizontal and vertical distances of the projectile from the point of projection. The maximum height attained by the particle and the angle of projection from the horizontal are

a) $\frac{b^2}{4b}, \tan^{-1}(b)$ b) $\frac{a^2}{b}, \tan^{-1}(2b)$ c) $\frac{a^2}{4b}, \tan^{-1}(a)$ d) $\frac{2a^2}{b}, \tan^{-1}(a)$

313. A body of mass 100 g is rotating in a circular path of radius r with constant velocity. The work done in one complete revolution is

a) $100\, rJ$ b) $(r/100)J$ c) $(100/r)J$ d) Zero

314. A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of P is such that it sweeps out length $s=t^3+5$, where s is in metre and t is in second. The radius of the path is 20 m. The acceleration of P when t=2s is nearly



a) 13 ms $^{-2}$ b) 12 ms $^{-2}$ c) 7.2 ms $^{-2}$ d) 14 ms $^{-2}$

315. A projectile is thrown in the upward direction making an angle of 60° with the horizontal direction with a velocity of 147 ms^{-1}. Then the time after which its inclination with the horizontal is 45°, is

a) 15 s b) 10.98 s c) 5.49 s d) 2.745 s

316. The kinetic energy k of a particle moving along a circle of radius R depends on the distance covered s as $k=as^2$ where a is a constant

a) $2a\frac{s^2}{R}$ b) $2as\left(1+\frac{s^2}{R^2}\right)^{1/2}$ c) $2as$ d) $2a\frac{R^2}{s}$

317. A heavy mass is attached to a thin wire and is whirled in a vertical circle. The wire is most likely to break

a) When the mass is at the highest point of the circle b) When the mass is the lowest point of the circle

c) When the wire is horizontal d) At an angle of $\cos^{-1}(1/3)$ from the upward

vertical

318. Three particles A, B and C are projected from the same point with the same initial speeds making angles $30°$, $45°$ and $60°$ respectively with the horizontally. Which of the following statements is correct?

a) A, B and C have unequal ranges

b) Range of A and C are less than that of B

c) Range of A and C are equal and greater than that of B

d) A, B and C have equal ranges

319. If $\vec{A} = \vec{B}$, then which of the following is not correct

a) $\hat{A} = \hat{B}$ b) $\hat{A} \cdot \hat{B} = AB$ c) $|\vec{A}| = |\vec{B}|$ d) $A\hat{B} \mid \quad \mid B\hat{A}$

320. A bomb is dropped on an enemy post by an aeroplane flying horizontally with a velocity of $60\ \text{kmh}^{-1}$ and at a height of 490 m. At the time of dropping the bomb, how far the aeroplane should be from the enemy post so that the bomb may directly hit the target?

a) $\frac{400}{3}$ m b) $\frac{500}{3}$ m c) $\frac{1700}{3}$ m d) 498 m

321. Two stones thrown at different angles have same initial velocity and same range. If H is the maximum height attained by one stone thrown at an angle of $30°$, then the maximum height attained by the other stone is

a) $\frac{H}{2}$ b) H c) $2H$ d) $3H$

322. A ball of mass m is thrown vertically upwards. Another ball of mass $2m$ is thrown at an angle θ with the vertical. Both of them stay in air for same period of time. The heights attained by the two balls are in the ratio of

a) $2:1$ b) $1:\cos\theta$ c) $1:1$ d) $\cos\theta : 1$

323. A projectile of mass m is thrown with a velocity v making an angle of $45°$ with the horizontal. The change in momentum from departure to arrival along vertical direction, is

a) $2mv$ b) $\sqrt{2}\,mv$ c) mv d) $\frac{mv}{2}$

324. The resultant of two forces at right angle is 5N. When the angle between them is $120°$, the resultant is $\sqrt{13}$. Then the force are

a) $\sqrt{12}$N, $\sqrt{13}$N b) $\sqrt{20}$N, $\sqrt{5}$N c) 3 N, 4 N d) $\sqrt{40}$N, $\sqrt{15}$N

325. A bridge is in the form of a semi-circle of radius $40m$. The greatest speed with which a motor cycle can cross the bridge without leaving the ground at the highest point is ($g = 10\ ms^{-2}$) (frictional force is negligibly small)

a) $40\ ms^{-1}$ b) $20\ ms^{-1}$ c) $30\ ms^{-1}$ d) $15\ ms^{-1}$

326. A particle crossing the origin of co-ordinates at time $t = 0$, moves in the xy-plane with a constant acceleration a in the y-direction. If its equation of motion is $y = bx^2$ (b is a constant), its velocity component in the x-direction is

a) $\sqrt{\frac{2b}{a}}$ b) $\sqrt{\frac{a}{2b}}$ c) $\sqrt{\frac{a}{b}}$ d) $\sqrt{\frac{b}{a}}$

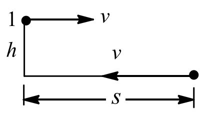
327. A 500 kg car takes a round turn of radius 50 m with a velocity of 36 km/hr. The centripetal force is

a) 250 N b) 750 N c) 1000 N d) 1200 N

328. A body is thrown with a velocity of $10\ \text{ms}^{-1}$ at an angle of $60°$ with the horizontal. Its velocity at the highest point is

a) $7\ \text{ms}^{-1}$ b) $9\ \text{ms}^{-1}$ c) $18.7\ \text{ms}^{-1}$ d) $5\ \text{ms}^{-1}$

329. Two particles 1 and 2 are projected with same speed v as shown in figure. Particle 2 is on the ground and particle 1 is at a height h from the ground and at a horizontal distance s from particle 2. If a graph is plotted between v and s for the condition of collision of the two then (v on y-axis and s on x-axis)



a) It will be a parabola passing through the origin

b) It will be straight line passing through the origin and having a slope of $\sqrt{\frac{g}{8h}}$

c) It will be a straight line passing through the origin and having a slope of $\sqrt{\frac{g}{4h}}$

d) It will be a straight line not passing through the origin

330. A stone tied to one end of rope and rotated in a circular motion. If the string suddenly breaks, then the stone travels

a) in perpendicular direction

b) in direction of centrifugal force

c) towards centripetal force

d) in tangential direction

331. A particle moves in a circle of radius 30 cm. Its linear speed is given by $v = 2t$ where t in second and $v$in m/s. Find out its radial and tangential acceleration at $t = 3\ sec$ respectively

a) 220 $m/\sec^2$, 50 $m/\sec^2$ b) 100 $m/\sec^2$, 5 $m/\sec^2$

c) 120 $m/\sec^2$, 2 $m/\sec^2$ d) 110 $m/\sec^2$, 10 $m/\sec^2$

332. A particle moves with constant speed v along a circular path of radius r and completes the circle in time T. The acceleration of the particle is

a) $2\pi v/T$ b) $2\pi r/T$ c) $2\pi r^2/T$ d) $2\pi v^2/T$

333. A particle is projected up an inclined plane with initial speed $v = 20\text{ms}^{-1}$ at an angle $\theta = 30°$ with plane. The component of its velocity perpendicular to plane when it strikes the plane is

a) $10\sqrt{3}\ \text{ms}^{-1}$ b) $10\ \text{ms}^{-1}$

c) $5\sqrt{3}\ \text{ms}^{-1}$ d) Data is insufficient

334. An aircraft is flying at a height of 3400 m above the ground. If the angle subtended at a ground observation point by the aircraft position 10 s apart is 30°, then the speed of the aircraft is

a) 19.63 ms^{-1} b) 1963 ms^{-1} c) 108 ms^{-1} d) 196.3 ms^{-1}

335. A body constrained to move in Y direction, is subjected to a force given by $\vec{F} = (-2\hat{i} + 15\hat{j} + 6\hat{k})$N done by this force in moving the body through a distance of 10m along Y axis?

a) 190 J b) 160 J c) 150 J d) 20 J

336. A body moves with constant angular velocity on a circle. Magnitude of angular acceleration

a) $r\omega^2$ b) Constant c) Zero d) None of the above

337. The sum of two vectors $\vec{A}$ and $\vec{B}$ is at right angles to their difference. Then

a) $A = B$

b) $A = 2B$

c) $B = 2A$

d) $\vec{A}$ and $\vec{B}$ have the same direction

338. A projectile is projected with kinetic energy K. If it has the maximum possible horizontal range, then its kinetic energy at the highest point will be

a) 0.25 K b) 0.5 K c) 0.75 K d) 1.0 K

339. Two particles of equal masses are revolving in circular paths of radii r_1 and r_2 respectively with the same speed. The ratio of their centripetal forces is

a) $\frac{r_2}{r_1}$ b) $\sqrt{\frac{r_2}{r_1}}$ c) $\left(\frac{r_1}{r_2}\right)^2$ d) $\left(\frac{r_2}{r_1}\right)^2$

340. A scooter is going round a circular road of radius 100 m at a speed of 10 m/s. The angular speed of the scooter will be

a) 0.01 rad/s b) 0.1 rad/s c) 1 rad/s d) 10 rad/s

341. A car rounds an unbanked curve of radius 92 m without skidding at a speed of 26 ms^{-1}. The smallest possible coefficient of static friction between the tyres and the road is

a) 0.75 b) 0.60 c) 0.45 d) 0.30

342. A body of mass 5 kg is whirled in a vertical circle by a string 1 m long. Calculate velocity at the top of the circle for just looping the vertical loop

a) 3.1 ms^{-1} b) 7 ms^{-1} c) 9 ms^{-1} d) 7.3 ms^{-1}

343. A cricketer can throw a ball to a maximum horizontal distance of 100 m. The speed with which he throws the ball is (to the nearest integer)

a) 30 ms^{-1} b) 42 ms^{-1} c) 32 ms^{-1} d) 35 ms^{-1}

344. A cyclist riding the bicycle at a speed of $14\sqrt{3}\ ms^{-1}$ takes a turn around a circular road of radius $20\sqrt{3}\ m$ without skidding. Given $g = 9.8\ ms^{-2}$, what is his inclination to the vertical

a) 30° b) 90° c) 45° d) 60°

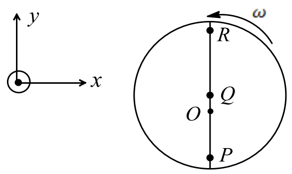
345. Two projectile are thrown with the same initial velocity at angles α and (90° − α) with the horizontal. The maximum heights attained by them are h_1 and h_2 respectively. Then $\frac{h_1}{h_2}$ is equal to

a) $\sin^2 \alpha$ b) $\cos^2 \alpha$ c) $\tan^2 \alpha$ d) 1

346. The average acceleration vector for a particle having a uniform circular motion is

a) A constant vector of magnitude v^2/r
b) A vector of magnitude v^2/r directed normal to the plane of the given uniform circular motion
c) Equal to the instantaneous acceleration vector at the start of the motion
d) A null vector

347. Consider a disc rotating in the horizontal plane with a constant angular speed ω about its centre O. The disc has a shaded region on one side of the diameter and an unshanded region on the other side as shown in the figure. When the disc is in the orientation as shown, two pebbles P and Q are simultaneously projected at an angle towards R. The velocity of projection is in the $y - z$ plane and is same for both pebbles with respect to the disc. Assume that (i) they land back on the disc before the disc has completed $\frac{1}{8}$ rotation. (ii) their range is less than half the disc radius, and (iii) ω remains constant throughout. Then



a) P lands in the shaded region and Q in the unshaded region
b) P lands in the unshaded region and Q in the shaded region
c) Both P and Q land in the unshaded region
d) Both P and Q land in the shaded region

348. A ball is moving to and fro about the lowest point A of a smooth hemispherical bowl. If it is able to rise up to a height of 20 cm on either side of A, its speed at A must be ($Take\ g = 10\ m/s^2$, massof the body 5 g)

a) 0.2 m/s b) 2 m/s c) 4 m/s d) 4.5 ms^{-1}

349. What is the angle between $(\hat{i} + 2\hat{j} + 2\hat{k})$ and $\hat{i}$

a) 0° b) $\pi/6$ c) $\pi/3$ d) None of these

350. A force of $(10\hat{i} - 3\hat{j} + 6\hat{k})$ N acts on a body of mass 100 g and displaces it from $(6\hat{i} + 5\hat{j} - 3\hat{k})$ m to $(10\hat{i} - 2\hat{j} + 7\hat{k})$ m. The work done is

a) 21 J b) 121 J c) 361 J d) 1000 J

351. A bridge is in the form of a semi-circle of radius 40 m. The greatest speed with which a motor cycle can cross the bridge without leaving the ground at the highest point is($g = 10 ms^{-2}$)(frictional force is negligibly small)

a) 40 ms^{-1} b) 20 ms^{-1} c) 30 ms^{-1} d) 15 ms^{-1}

352. A body is projected at such angle that the horizontal range is three times the greatest height. The angel of projection is

a) 42°8′ b) 53°7′ c) 33°7′ d) 25°8′

353. The maximum and minimum tension in the string whirling in a circle of radius 2.5 m with constant velocity are in the ratio 5 : 3 then its velocity is

a) $\sqrt{98}\ ms^{-1}$ b) 7 ms^{-1} c) $\sqrt{490}\ ms^{-1}$ d) $\sqrt{4.9}\ ms^{-1}$

354. A body of mass $\sqrt{3}$ kg is suspended by a string from a rigid support. The body is pulled horizontally by a force F until the string makes an angle of 30° with the vertical. The value o F and tension in the string are

a) 19.6 N; 19.6 N b) 9.8 N; 9.8 N c) 9.8 N, 19.6 N d) 19.6 N, 9.8 N

355. A sphere of mass 0.2 kg is attached to an inextensible string of length 0.5 m whose upper end is fixed to the ceiling. The sphere is made to describe a horizontal circle of radius 0.3 m. The speed of the sphere will be

a) 1.5 m s^{-1} b) 2.5 m s^{-1} c) 3.2 m s^{-1} d) 4.7 m s^{-1}

356. A bullet is fired from a cannon with velocity 500 m/s . If the angle of projection is 15°and $g = 10\ m/s^2$. Then the range is

a) $25 \times 10^3\ m$ b) $12.5 \times 10^3\ m$ c) $50 \times 10^2\ m$ d) $25 \times 10^2\ m$

357. Find the maximum speed at which a car can turn round a curve of 30 m radius on a level road if the coefficient of friction between the tyres and the road is 0.4

(Acceleration due to gravity = 10 ms^{-2})

a) 12 ms $^{-2}$ b) 10 ms $^{-2}$ c) 11 ms $^{-2}$ d) 15 ms $^{-2}$

358. A simple pendulum oscillates in a vertical plane. When it passes through the mean position, the tension in the string is 3 times the weight of the pendulum bob. What is the maximum displacement of the pendulum with respect to the vertical

a) 30° b) 45° c) 60° d) 90°

359. A particle is moving in a circle of radius R with constant speed$v$. If radius is doubled, then its centripetal force to keep the same speed gets

a) twice as great as before b) half

c) one-fourth d) remains constant

360. A ball is projected with kinetic energy E at an angle of 45° to the horizontal. At the highest point during its flight, its kinetic energy will be

a) Zero b) $E/2$ c) $E/\sqrt{2}$ d) E

361. Given that A and B are greater than 1. The magnitude of $(\vec{A} \times \vec{B})$ can not be

a) equal to AB b) less than AB c) more than AB d) equal to A/B

362. The string of pendulum of length l is displaced through 90° from the vertical and released. Then the minimum strength of the string in order to withstand the tension, as the pendulum passes through the mean position is

a) mg b) $3mg$ c) $5\ mg$ d) $6\ mg$

363. A car is moving on a circular road of diameter 50 m with a speed of 5 ms^{-1}. It is suddenly accelerated at rate 1 ms^{-2}. If the mass is 500 kg, find the net force acting on the car

a) 5 N b) 1000 N c) $500\sqrt{2}$N d) $500/\sqrt{2}$ N

364. A bomb is dropped from an aeroplane flying horizontally with a velocity 469 ms^{-1} at an altitude of 980 m. The bomb will hit the ground after a time

a) 2 s b) $\sqrt{2}$ s c) $5\sqrt{2}$ s d) $10\sqrt{2}$ s

365. Following forces start acting on a particle at rest at the origin of the co-ordinate system simultaneously

$\vec{F}_1 = 5\hat{i} - 5\hat{j} + 5\hat{k}$, $F_2 = 2\hat{i} + 8\hat{j} + 6\hat{k}, F_3 = -6\hat{i} + 4\hat{j} - 7\hat{k}$,

$F_4 = -\hat{i} - 3\hat{j} - 2\hat{k}$. The particle will move

a) in $x - y$ plane b) in $y - z$ plane c) in $x - z$ plane d) along x-axis

366. If $0.5\hat{i} + 0.8\hat{j} + c\hat{k}$ is a unit vector, then the value of c is

a) $\sqrt{0.11}$ b) $\sqrt{0.22}$ c) $\sqrt{0.33}$ d) $\sqrt{0.89}$

367. A cyclist goes round a circular path of circumference 34.3 m in $\sqrt{22}$s, the angle made by him with the vertical will be

a) 45° b) 40° c) 42° d) 48°

368. The simple sum of two co-initial vectors is 10 units. Their vector sum is 8 units. The resultant of the vectors is perpendicular to the smaller vector. The magnitudes of the two vectors are

a) 2 units and 14 units

b) 4 units and 12 units
c) 6 units and 10 units
d) 8 units and 8 units

369. A particle is projected with a velocity v such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is (where g is acceleration due to gravity)
a) $\frac{4v^2}{5g}$ b) $\frac{4g}{5v^2}$ c) $\frac{v^2}{g}$ d) $\frac{4v^2}{\sqrt{5}g}$

370. A mass of 2 kg is whirle'd in a horizontal circle by means of a string at an initial speed of 5 revolutions per minute. Keeping the radius constant, the tension in the string is double. The new speed is nearly
a) 2.25 rpm b) 7 rpm c) 10 rpm d) 14 rpm

371. A point of application of a force $\vec{F} = 5\hat{i} - 4\hat{j} + 2\hat{k}$ is moved from $\vec{r_1} = 2\hat{i} + 7\hat{j} + 4\hat{k}$ to $\vec{r_2} = 5\hat{i} + 2\hat{j} + 3\hat{k}$ the work done is
a) 22 units b) −22 units c) 33 units d) −33 units

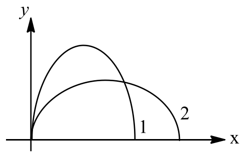
372. A particle performing uniform circular motion has
a) Radial velocity and radial acceleration
b) A radial velocity and transverse acceleration
c) Transverse velocity and radial acceleration
d) Transverse velocity and transverse acceleration

373. The velocity of projection of an oblique projectile is $(6\hat{\mathbf{i}} + 8\hat{\mathbf{j}})\text{ms}^{-1}$. The horizontal range of the projectile is
a) 4.9 m b) 9.6 m c) 19.6 m d) 14 m

374. One o the rectangular components of a velocity of 60kmh^{-1} is 30 kmh^{-1}. The other rectangular component is
a) 30 kmh^{-1} b) $30\sqrt{3}\ \text{kmh}^{-1}$ c) $30\sqrt{2}\ \text{kmh}^{-1}$ d) Zero

375. The sum of the magnitudes of two forces acting at a point is 16 N. the resultant of these forces is perpendicular to the smaller force has a magnitude of 8 N. If the smaller force is magnitude x, then the value of x is
a) 2 N b) 4 N c) 6 N d) 7 N

376. Trajectories of two projectiles are shown in figure. Let $T_1$and T_2 be the time periods and u_1 and u_2 their speeds of projection. Then



a) $T_2 > T_1$ b) $T_1 = T_2$ c) $u_1 > u_2$ d) $u_1 < u_2$

377. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/sec. A plumb bob is suspended from the roof of the car by a light rigid rod of length 1.00 m. The angle made by the rod with track is
a) Zero b) 30° c) 45° d) 60°

378. The horizontal and vertical displacement x and y of a projectile at a given time t are given by $x = 6t$ metre and $y = 8t - 5t^2$ metre. The range of the projectile in metre is
a) 9.6 b) 10.6 c) 19.2 d) 38.4

379. A projectile is projected with a speed u making an angle 2θ with the horizontal. What is the speed when its direction of motion makes an angle θ with the horizontal
a) $(u\cos 2\theta)/2$ b) $u\cos\theta$ c) $u(2\cos\theta - \sec\theta)$ d) $u(\cos\theta - \sec\theta)$

380. Two stones are projected with the same velocity in magnitude but making different angles with the horizontal. Their ranges are equal. If the angel of projection of one is π/3 and its maximum height is y_1, the maximum height of the other will be
a) $3y_1$ b) $2y_1$ c) $\frac{y_1}{2}$ d) $\frac{y_1}{3}$

381. A glass marble projected horizontally from the top of a table falls at a distance x from the edge of the table.

If h is the height of the table, then the velocity of projection is

a) $h\sqrt{\frac{g}{2x}}$ b) $x\sqrt{\frac{g}{2h}}$ c) gxh d) $gx + h$

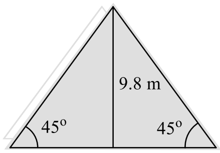
382. A bucket full of water is revolved in vertical circle of radius $2m$. What should be the maximum time-period of revolution so that the water doesn't fall of the bucket

a) 1 sec b) 2 sec c) 3 sec d) 4 sec

383. Which of the following sets of factors will affect the horizontal distance covered by an athlete in a long-jump event

a) Speed before he jumps and his weight
b) The direction in which he leaps and the initial speed
c) The force with which he pushes the ground and his speed
d) None of these

384. Two inclined planes are located as shown in figure. A particle is projected from the foot of one frictionless plane along its line with a velocity just sufficient to carry it to top after which the particle slides down the other frictionless inclined plane. The total time it will take to reach the point C is



a) 2 s b) 3 s c) $2\sqrt{2}$ s d) 4 s

385. A ball rolls of the top of a stair way with a horizontal velocity u ms^{-1}. If the steps are h metre and b metre wide, the ball hits the edge of nth step, the time taken by the ball is

a) $\frac{hu}{gb}$ b) $\frac{2hu}{gb}$ c) $\frac{2hu^2}{gb}$ d) $\frac{hu^2}{2gb}$

386. An airplane, diving at an angle of 53.0° with the vertical releases a projectile at an altitude of 730 m. The projectile hits the ground 5.00 s after being released. What is the speed of the aircraft?

a) 282 ms^{-1} b) 202 ms^{-1} c) 182 ms^{-1} d) 102 ms^{-1}

387. A body of mass m hangs at one end of a string of length l, the other end of which is fixed. It is given a horizontal velocity so that the string would just reach where it makes an angle of 60° with the vertical. The tension in the string at mean position is

a) 2 mg b) mg c) $3mg$ d) $\sqrt{3}mg$

388. A cyclist goes round a circular path of circumference 34.3 m in $\sqrt{22}$ sec. the angle made by him, with the vertical, will be

a) 45° b) 40° c) 42° d) 48°

389. A1 kg stone at the end of 1 m long string is whirled in a vertical circle at constant speed of 4 m/sec. The tension in the string is 6 N, when the stone is at ($g = 10\ m/\sec^2$)

a) Top of the circle b) Bottom of the circle c) Half way down d) None of the above

390. A curved road of diameter 1.8 km is banked so that no friction is required at a speed of 30 ms^{-1}. What is the banking angle?

a) 6° b) 16° c) 26° d) 0.6°

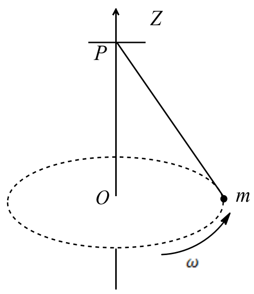
391. A stone tied to the end of a string $1m$ long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolution in 44 seconds, what is the magnitude and direction of acceleration of the stone

a) $\pi^2/4\ ms^{-2}$ and direction along the radius towards the centre
b) $\pi^2 ms^{-2}$ and direction along the radius away from the centre
c) $\pi^2 ms^{-2}$ and direction along the radius towards the centre
d) $\pi^2 ms^{-2}$ and direction along the tangent to the circle

392. A fly wheel rotates about a fixed axis and slows down from 300 rpm to 100 rpm in 2 min. Then its angular retardation in rad/min^2 is

a) $\frac{100}{\pi}$ b) 100 c) 100 π d) 200 π

393. A small mass m is attached to a massless string whose other end is fixed at P as shown in the figure. The mass is undergoing circular motion in the $x-y$ plane with centre at O and constant angular speed ω. If the angular momentum of the system, calculated about O and P are denoted by $\vec{L}_O$ and $\vec{L}_P$ respectively, then



a) $\vec{L}_O$ and $\vec{L}_P$ do not vary with time
b) $\vec{L}_O$ varies with time while $\vec{L}_P$ remains constant
c) $\vec{L}_O$ remains constant while $\vec{L}_P$ varies with time
d) $\vec{L}_O$ and $\vec{L}_P$ both vary with time

394. A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as, $a_c = k^2rt^2$, The power delivered to the particle by the forces acting on it is

a) $2\pi mk^2r^2t$
b) mk^2r^2t
c) $\frac{mk^4r^2t^5}{3}$
d) Zero

395. A man projects a coin upwards from the gate of a uniformly moving train. The path of coin for the man will be

a) Parabolic
b) Inclined straight line
c) Vertical straight line
d) Horizontal straight line

396. A piece of marble is projected from earth's surface with velocity of 50ms^{-1}. 2 s later, it just clears a wall 5 m high. What is the angle of projection?

a) 45°
b) 30°
c) 60°
d) None of these

397. A ball rolls off the top of a stairway with horizontal velocity $v_0 ms^{-1}$. If the steps are h metre high and w metre wide, the ball will hit the edge of nth step if

a) $n = \frac{2hv_0}{gw^2}$
b) $n = \frac{2hv_0^2}{gw}$
c) $n = \frac{hv_0^2}{gw^2}$
d) $n = \frac{2hv_0^2}{gw^2}$

398. A particle is projected from the ground at an angle of 60° with horizontal with speed $u = 20\text{ ms}^{-1}$. The radius of curvature of the path of the particle, when its velocity makes an angle of 30° with horizontal is ($\text{g} = 10\text{ ms}^{-2}$)

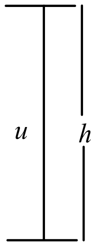
a) 10.6 m
b) 12.8 m
c) 15.4 m
d) 24.2 m

1 **(c)**

$$h = \frac{u^2}{2g} \Longrightarrow u^2 = 2gh$$

Maximum horizontal distance

$$R_{\max} = \frac{u^2}{g}$$



$R_{\max} = 2h$

2 **(c)**

$$v = \sqrt{2gl(1-\cos\theta)}$$

$$= \sqrt{2 \times 9.8 \times 2(1-\cos 60°)}$$

$$= 4.43\ m/s$$

3 **(c)**

Using relation $\theta = \omega_0 t + \frac{1}{2}at^2$

$\theta_1 = \frac{1}{2}(\alpha)(2)^2 = 2\alpha \qquad$ ...(i)

As $\omega_0 = 0, t = 2\ sec$

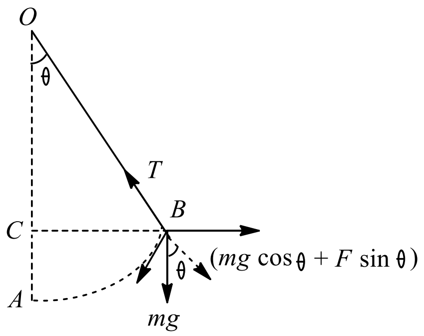
Now using same equation for $t = 4\ sec, \omega_0 = 0$

$\theta_1 + \theta_2 = \frac{1}{2}\alpha(4)^2 = 8\alpha \qquad$ ...(ii)

From (i) and (ii), $\theta_1 = 2\alpha$ and $\theta_2 = 6\alpha$ $\therefore \frac{\theta_2}{\theta_1} = 3$

4 **(c)**

Centrifugal force on rod,$F = \frac{mv^2}{r}$ along BF. Let θ be the angle which the rod makes with the vertical. Forces acting on the rod are shown in figure



Resolving mg and F into two rectangular components, we have,

Forces parallel to rod,

$$mg\cos\theta + \frac{mv^2}{r}\sin\theta = T$$

Force perpendicular rod

$$= mg\sin\theta - \frac{mv^2}{r}\cos\theta$$

The rod will be balanced if

$$mg\sin\theta = \frac{mv^2}{r}\cos\theta = 0$$

or $mg\sin\theta = \frac{mv^2}{r}\cos\theta$

or $\tan\theta = \frac{v^2}{rg} = \frac{(10)^2}{10\times10} = 1 = \tan 45°$or $\theta = 45°$

5 **(b)**

Tangential acceleration, $a_t = \frac{v_f - v_i}{t}$

$$= \left(\frac{45-60}{8}\right)\frac{22}{15}\text{fts}^{-1}$$

$$= -\frac{11}{4}\text{fts}^{-2}$$

Radial acceleration, $a_r = \frac{v^2}{r} = \frac{\left(60 \times \frac{22}{15}\right)^2}{2500}$

$$= 3.1\ \text{fts}^{-2}$$

Then, $\quad a = \sqrt{a_r^2 + a_t^2} = 4.14\ \text{fts}^{-2}$

6 **(d)**

We know that if two stones have same horizontal range, then this implies that both are projected at θ and 90° − θ.

Given, $\theta = \frac{\pi}{3} = 60°$

$\therefore\ 90° - \theta = 90° - 60° = 30°$

For first stone,

Maximum height $= 102 = \frac{u^2\sin^2 60°}{2g}$

For second stone,

Maximum height, $h = \frac{u^2\sin^2 30°}{2g}$

$$\therefore \frac{h}{102} = \frac{\sin^2 30°}{\sin^2 60°} = \frac{(1/2)^2}{(\sqrt{3}/2)^2}$$

or $h = 102 \times \frac{1/4}{3/4} = 34$ m

7 **(b)**

Acceleration of the particle is

$a = r\omega^2 = r(2\pi n)^2$

$= 0.25 \times (2\pi \times 2)^2$

$= 16\pi^2 \times 0.25$

$= 4\pi^2\text{ms}^{-2}$

8 **(c)**

$\mathbf{L} = m(\mathbf{r} \times \mathbf{v})$

$$\mathbf{L} = m\left[v_0\cos\theta\, t\hat{\mathbf{i}} + \left(v_0\sin\theta\, t - \frac{1}{2}gt^2\right)\hat{\mathbf{j}}\right]$$

$$\times \left[v_0\cos\theta\,\hat{\mathbf{i}} + (v_0\sin\theta - gt)\hat{\mathbf{j}}\right]$$

$$= mv_0\cos\theta\, t\left[-\frac{1}{2}gt\right]\hat{\mathbf{k}}$$

$$= -\frac{1}{2}mgv_0t^2\cos\theta\hat{\mathbf{k}}$$

9 **(a)**

When a body moves on a circular path then force and distance are perpendicular to each other. Therefore, work done by the force is

$W = F \cdot d\cos\theta$

$= F \cdot d\cos 90°\ (\because \theta = 90°)$

$= 0 \quad (\because \cos 90° = 0)$

10 **(b)**

Since $\vec{F} = 4\hat{i} - 3\hat{j}$ is lying in $X - Y$ plane, hence the vector perpendicular to $\vec{F}$ must be lying perpendicular to $X - Y$ plane *ie*, along Z-axis.

11 **(c)**

If a particle is projected with velocity u at an angle θ with the horizontal, the velocity of the particle at the highest point is

$v = u\cos\theta = 200\cos 60° = 100\ \text{ms}^{-1}$

If m is the mass of the particle, then its initial momentum at highest point in the horizontal direction $= mv = m \times 100$. It means at the highest point, initially the particle has no momentum vertically upwards or downwards. Therefore, after explosion, the final momentum of the particles going upwards and downwards must be zero. Hence, the final momentum after explosion is the momentum of the third particle, in the horizontal direction. If the third particle moves with velocity v', then its momentum $= \frac{mv'}{3}$,

According to law of conservation of linear momentum,

We have $\frac{mv'}{3} = m \times 100$ or $v' = 300\ \text{ms}^{-1}$

12 **(b)**

Maximum height, $H = \frac{u^2\sin^2\theta}{2g}$

$\frac{dH}{du} = \frac{2u^2\sin^2\theta}{2g}$ or $dH = \frac{u\ \ \sin^2\theta}{g}du$

$\therefore \frac{dH}{H} = \frac{2du}{u}$

Since H is increased by 10%

So, $\frac{dH}{H} = \frac{10}{100} = \frac{1}{10} = \frac{2du}{u}$

Now horizontal range, $dR = \frac{2u}{g}\sin 2\theta\, du$

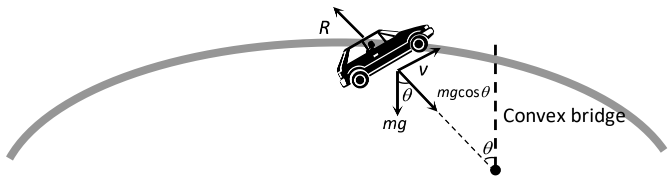
or $\frac{dR}{R} = \frac{2du}{u} = \frac{1}{10}$

$\therefore$ % increase in $R = \frac{dR}{R} \times 100$

$= \frac{1}{10} \times 100 = 10\ \%$

13 **(a)**

$R = mg\cos\theta - \frac{mv^2}{r}$



When θ decreases $\cos\theta$ increases $i.e.$, R increases

14 **(c)**

Here, $r = 300$ m, $\mu = 0.3$, $g = 10\ \text{ms}^{-2}$

$v_{\max} = \sqrt{\mu rg} = \sqrt{0.3 \times 300 \times 10} = 30\ \text{ms}^{-1}$

$= 30 \times \frac{18}{5}\text{km h}^{-1} = 108\ \text{km h}^{-1}$

15 **(b)**

Centripetal force $= mr\omega^2 = 5 \times 1 \times (2)^2 = 20\ N$

16 **(b)**

Let $\hat{A} + \hat{B} = \hat{R}$ then using parallelogram law of vectors we have

$1 = (1^2 + 1^2 + 2.1.1\cos\theta)^{1/2}$

or $\quad 1 = 2(1 + \cos\theta)$

or $\quad \frac{1}{2} - 1 = \cos\theta$

or $\quad \cos\theta = -\frac{1}{2} = \cos 120°$

or $\quad \theta = 120°$

$\therefore\ |\hat{A} - \hat{B}| = |\hat{A} + (-\hat{B})|$.

Now the angle between $\hat{A}$ and $-\hat{B}$ is 60°

The resultant of $|\hat{A} + (-\hat{B})|$

$(1^2 + 1^2 + 2 \times 1 \times 1 \times \cos 60°)^{1/2}$

$= \sqrt{3}$

17 **(c)**

Displacement, $\vec{r} = (a\hat{i} + a\hat{j}) - (a\hat{i}) = a\hat{j}$

$\vec{F} = -K(y\hat{i} + x\hat{j}) = -K(a\hat{i} + a\hat{j})$

Workdone, $\ W = \vec{F}.\vec{r}$

$= -K(a\hat{i} + a\hat{j}).\,a\hat{j} = -Ka^2$

18 **(c)**

We know that range of projectile is same for complementary angles *ie*, for θ and $(90° - \theta)$.

$\therefore\ T_1 = \frac{2u\sin\theta}{g}$

$T_2 = \frac{2u\sin(90° - \theta)}{g} = \frac{2u\cos\theta}{g}$

and $\ R = \frac{u^2\sin\theta}{g}$

Therefore, $\quad T_1T_2 = \frac{2u\sin\theta}{g} \times \frac{2u\cos\theta}{g}$

$= \frac{2u^2(2\sin\theta\cos\theta)}{g^2}$

$= \frac{2u^2(2\sin\theta)}{g^2} = \frac{2R}{g}$

$\therefore\ T_1T_2 \propto R$

19 **(a)**

$$R=\frac{v^2\sin 2\theta}{g}=200, T=\frac{2v\sin\theta}{g}=5$$

Dividing, $\frac{v^2\times 2\sin\theta\cos\theta}{g}\times\frac{g}{2v\sin\theta}=\frac{200}{5}=40$

or $v\cos\theta=40\text{ms}^{-1}$

It may be noted here that the horizontal component of the velocity of projection remains the same during the flight of the projectile

20 **(c)**

$\cos\theta=\vec{A}\cdot\vec{B}/AB$

21 **(c)**

For looping the loop, the velocity at the lowest point of loop should be

$v=\sqrt{5gr}=\sqrt{5gD/2}=\sqrt{2gh}$ or $h=5\,D/4$

22 **(d)**

Angular momentum is an axial vector. It is directed always in a fix direction (perpendicular to the plane of rotation either outward or inward), if the sense of rotation remain same

23 **(d)**

Since the maximum tension T_B in the string moving in the vertical circle is at the bottom and minimum tension T_T is at the top

$\therefore T_B=\frac{mv_B^2}{L}+mg$ and $T_T=\frac{mv_T^2}{L}-mg$

$$\therefore\frac{T_B}{T_T}=\frac{\frac{mv_B^2}{L}+mg}{\frac{mv_T^2}{L}-mg}=\frac{4}{1}\text{ or }\frac{v_B^2+gL}{v_T^2-gL}=\frac{4}{1}$$

Or $v_B^2+gL=4v_T^2-4gL$ but $v_B^2=v_T^2+4gL$

$\therefore v_T^2+4gL+gL=4v_T^2-4gL\Rightarrow 3v_T^2=9gL$

$\therefore v_T^2=3\times g\times L=3\times 10\times\frac{10}{3}$ or $v_T=10\,m/\text{sec}$

24 **(d)**

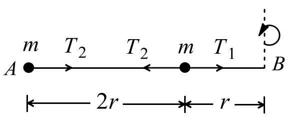
Here, $r=5$ m, $\mu=0.5, \omega=?, g=10\text{ms}^{-2}$

$mr\omega^2=F=\mu R=\mu\,mg$

$$\omega=\sqrt{\frac{\mu g}{r}}=\sqrt{\frac{0.5\times 10}{5}}=1\text{ rad s}^{-1}$$

25 **(a)**

Tensions in the respective parts are shown in figure



Let ω be angular velocity, then

$T_1-T_2=m\omega^2\times r$ ...(i)

and $T_2=m\omega^2(r+2r)$

$T_2=3m\omega^2 r$ ...(ii)

From equation (i) and (ii)

$$T_1=4m\omega^2 r\Rightarrow\frac{T_1}{T_2}=\frac{4}{3}$$

26 **(a)**

At the highest point, velocity is horizontal

27 **(d)**

Centripetal acceleration, $a=\omega^2 r$

$$=4\pi^2 n^2 r=4\pi^2\left(\frac{1}{2}\right)^2\times 100$$

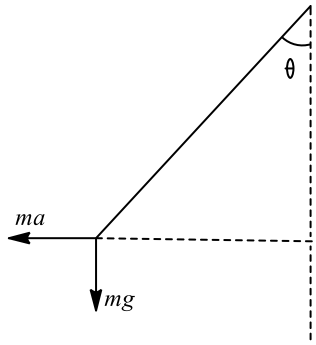
$\pi^2\times 100\text{ms}^{-2}=985.9\text{ms}^{-2}$

28 **(a)**

For horizontal planes potential energy remains constant equal to zero, if we assumes surface to be the zero level.

29 **(a)**

Let the angle from the vertical be θ. The diagram showing the different forces is given



Form the figure, $\tan\theta=\frac{a}{g}$

$$\theta=\tan^{-1}\frac{a}{g}$$

30 **(b)**

$\frac{v}{g}=20$ or $v^2=20g=20\times 9.8=196, v$

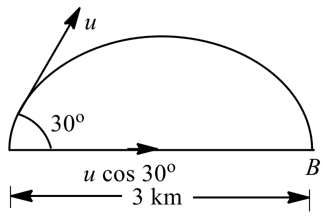
$=14\text{ ms}^{-1}$

31 **(c)**

Kinetic energy at highest point $=K\cos^2 45°=\frac{K}{2}$

32 **(b)**

The body covers a horizontal distance AB during its flight. This horizontal range is given by



$R=\frac{u^2\sin 2\theta}{g}$ .... (i)

For maximum horizontal range, $\sin 2\theta=1$

$\therefore R_{\max}=\frac{u^2}{g}$ ... (ii)

Given, $R = 3\text{km}, \quad \theta = 30°$

$\therefore$ From Eq. (i)

$$\frac{u^2}{g} = \frac{R}{\sin 2\theta} = \frac{3}{\sin 60°} = \frac{3 \times 2}{\sqrt{3}} = \sqrt{3} \times 2$$

$$\frac{u^2}{g} = 3.464\text{m} \quad \text{or } R_{\max} = 3.46\text{cm}$$

Hence, maximum range with velocity of projection u cannot be more than 3.464 m, Hence, it is not possible to hit a target 5 km away.

33 **(a)**

In uniform circular motion the only force acting on the particle is centripetal (towards centre). Torque of this force about the centre is zero. Hence angular momentum about centre remains conserved.

34 **(d)**

$$\theta = 2\pi n = \omega_0 t + \frac{1}{2}\alpha t^2$$

$2\pi \times 10 = \frac{1}{2}\alpha 4^2$ or $\alpha = \frac{40\pi}{16}$

Let it make N rotations in the first 8 s

Then, $2\pi N = \frac{1}{2}\alpha\, 8^2$

or $N = \frac{1}{2\pi} \times \frac{64}{2} \times \frac{40\pi}{16} = 40$

$\therefore$ The required number of rotations

$= 40 - 10 = 30$

35 **(a)**

$\vec{A} \times \vec{B} = (2\hat{i} + 3\hat{j}) \times (\hat{i} + 4\hat{j})$

$= 8(\hat{i} \times \hat{j}) + 3(\hat{j} \times \hat{i}) = 8\hat{k} - 3\hat{k} = 5\hat{k}$

36 **(a)**

$$t = \sqrt{\frac{2h}{g}}$$

Distance from the foot of the tower

$$d = vt = v\sqrt{\frac{2h}{g}} = 250\text{m}$$

When velocity $= \frac{v}{2}$

and height of tower$= 4h$

Then distance $x = \frac{v}{2}\sqrt{\frac{2(4h)}{g}}$

$$x = v\sqrt{\frac{2h}{g}} = 250 \text{ m}$$

37 **(c)**

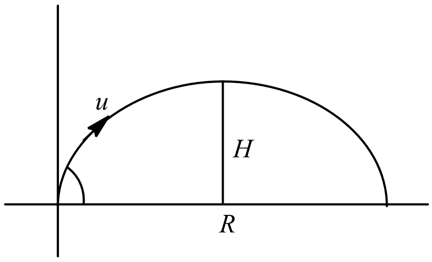
The range of particle is

$$R = \frac{u^2 \sin 2\theta}{g}$$

$$R = \frac{u^2 \sin 2 \times 45°}{g} \quad (\therefore \theta = 45°)$$

or $R = \frac{u^2 \sin 90°}{g}$

or $R = \frac{u^2}{g}$ .... (i)



Now, the maximum height of the particle is

$$H = \frac{u^2 \sin^2\theta}{2g}$$

$$= \frac{u^2 \sin^2 45°}{2g} = \frac{u^2\left(\frac{1}{\sqrt{2}}\right)^2}{2g}$$

$$= \frac{u^2}{4g} \quad \text{... (ii)}$$

Dividing Eqs. (i) by Eq. (ii),

$$\frac{R}{H} = \frac{u^2/g}{u^2/4g}$$

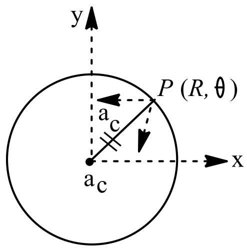
or $R = 4H$

38 **(c)**

Due to constant velocity along horizontal and vertical downward force of gravity stone will hit the ground following parabolic path

39 **(c)**

For a particle in uniform circular motion



$\mathbf{a} = \frac{v^2}{R} =$ towards center of circle

$$\mathbf{a} = \frac{v^2}{R}\left(-\cos\theta\,\hat{\mathbf{i}} - \sin\theta\,\hat{\mathbf{j}}\right)$$

$$\text{or}\,\mathbf{a} = \frac{v^2}{R}\cos\theta\,\hat{\mathbf{i}} - \frac{v^2}{R}\sin\theta\,\hat{\mathbf{j}}$$

40 **(b)**

$$T = \frac{2u\sin\theta}{g} = \frac{2 \times 9.8 \times \sin 30}{9.8} = 1\,s$$

41 **(a)**

The velocity should be such that the centripetal acceleration is equal to the acceleration due to

gravity $ie, v^2/R = \text{g}$ or $v = \sqrt{\text{g}R}$

42 **(a)**

The object will slip if centripetal force acting on it is more than friction force.

So, $mr\omega^2 > \mu mg$

$r\omega^2 \geq \mu g$

$r\omega^2 = \text{constant}$

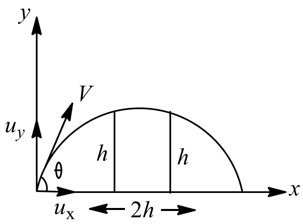
$\frac{r_1}{r_2} = \left(\frac{\omega_2}{\omega_1}\right)^2$

$\frac{4}{r_2} = \left(\frac{2\omega}{\omega}\right)^2$

$r_2 = 1$ cm

43 **(d)**

Let Δt be the time interval. Then,



$2h = (u_x)(\Delta t)$

or $u_x = \frac{2h}{\Delta t}$ ...(i)

Further, $h = u_y t - \frac{1}{2}\text{g}t^2$

or $\text{g}t^2 - 2u_y t + 2h = 0$

$$\therefore\ t_1 = \frac{2u_y + \sqrt{4u_y^2 - 8\text{g}h}}{2\text{g}}$$

and $t_2 = \frac{2u_y - \sqrt{4u_y^2 - 8\text{g}h}}{2\text{g}}$

$$\Delta t = t_1 - t_2 = \frac{\sqrt{4u_y^2 - 8\text{g}h}}{\text{g}}$$

or $u_y^2 = \frac{\text{g}^2(\Delta t)^2}{4} + 2\text{g}h$

Given, $u_x^2 + u_y^2 = \left(2\sqrt{\text{g}h}\right)^2$

$$\therefore\ \frac{4h^2}{(\Delta t)^2} + \frac{\text{g}^2(\Delta t)^2}{4} + 2\text{g}h = 4\text{g}h$$

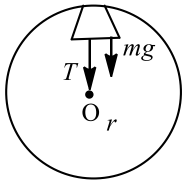
$$\frac{\text{g}^2}{4}(\Delta t)^4 - 2\text{g}h(\Delta t)^2 + 4h^2 = 0$$

$$(\Delta t)^2 = \frac{2\text{g}h \pm \sqrt{4\text{g}^2h^2 - 4\text{g}^2h^2}}{\text{g}^2/2} = \frac{4h}{\text{g}}$$

or $\Delta t = 2\sqrt{\frac{h}{\text{g}}}$

44 **(b)**

When a body is revolving in circular motion it is acted upon by a centripetal force directed towards the center. Water will not fall if weight is balanced by centripetal force. Therefore



$$mg = \frac{mv^2}{r}$$

$\Rightarrow v^2 = rg$ ... (i)

Circumference of a circle is $2\pi r$.

Time of revoluation $= \frac{2\pi r}{v}$

Putting the value of v from Eq. (i), we get

$$T = \frac{2\pi r}{\sqrt{gr}} = 2\pi\sqrt{\frac{r}{g}}$$

Given, $r = 4$ m, $g = 9.8\ \frac{\text{m}^2}{\text{s}}$

$$\therefore T = 2\pi\sqrt{\frac{4}{9.8}}$$

$$\Rightarrow T = \frac{4\pi}{\sqrt{9.8}} = 4\text{s}$$

45 **(b)**

$v = r\omega = 0.5 \times 70 = 35 m/s$

46 **(c)**

Total time of flight $= \frac{2u\sin\theta}{g} = \frac{2\times50\times1}{2\times10} = 5s$

Time to cross the wall $= 3\ sec$ (Given)

Time in air after crossing the wall $= (5-3) = 2\ sec$

$\therefore$ Distance travelled beyond the wall $= (u\cos\theta)t$

$= 50 \times \frac{\sqrt{3}}{2} \times 2 = 86.6\ m$

47 **(d)**

$v_x = \frac{dx}{dt} = 2ct$ and $v_y = \frac{dy}{dt} = 2bt$

$\therefore v = \sqrt{v_x^2 + v_y^2} = 2t(c^2 + b^2)^{1/2}$

48 **(c)**

When a force of constant magnitude acts on velocity of particle perpendicularly, then there is no change in the kinetic energy of particle. Hence, kinetic energy remains constant.

49 **(a)**

The maximum velocity for a banked road with friction,

$$v^2 = gr\left(\frac{\mu + \tan\theta}{1 - \mu\tan\theta}\right)$$

$$\Rightarrow v^2 = 9.8 \times 1000 \times \left(\frac{0.5 + 1}{1 - 0.5 \times 1}\right) \Rightarrow v$$

$$= 172 m/s$$

50 **(d)**

Here $W = T(\cos\theta + \sin\theta) < T$

so $P + Q = T(\cos\theta + \sin\theta) < T$

Where as (a), (b) and (c) are correct and (d) is wrong.

51 **(a)**

The angle of banking, $\tan\theta = \frac{v^2}{rg}$

$$\Rightarrow \tan 12^\circ = \frac{(150)^2}{r \times 10} \Rightarrow r = 10.6 \times 10^3 m$$
$$= 10.6\ km$$

52 **(b)**

Note that the angle between two forces is 120° and not 60°.

$R^2 = F^2 + F^2 + 2F^2\cos 120^\circ$

or $R^2 = 2F^2 + 2F^2\left(-\frac{1}{2}\right) = F^2$

or $R = F$

53 **(a)**

We know that $\tan\theta = \frac{v^2}{Rg}$ and $\tan\theta = \frac{h}{b}$

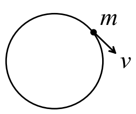
Hence $\frac{h}{b} = \frac{v^2}{Rg} \Rightarrow h = \frac{v^2 b}{Rg}$

54 **(a)**

There is no change in the angular velocity, when speed is constant

55 **(a)**

$\frac{v^2}{r} = a$, the centripetal acceleration [Given]



If v is doubled, $a'' = \frac{4v^2}{r} = 4a$

56 **(b)**

Difference in KE $= \frac{1}{2}m\left[\left(\sqrt{5gr}\right)^2 - \sqrt{gr}\right]^2$

$= 2mgr = 2 \times 1 \times 10 \times 1 = 20$ J

57 **(a)**

At the highest point of trajectory, the velocity becomes horizontal. So, it is perpendicular to acceleration (which is directed vertically downwards)

58 **(c)**

Difference in K.E. = Difference in P.E. $= 2mgr$

59 **(d)**

$p = mv\cos\theta$

$$= 1 \times 10 \times \cos 60^\circ = 10\left(\frac{1}{2}\right) \text{kg ms}^{-1}$$
$$= 5 \text{ kg ms}^{-1}$$

60 **(c)**

$$T = \frac{2 \times 50 \times \frac{1}{2}}{10} = 5 \text{ s}$$

Horizontal distance travelled in last 2 s

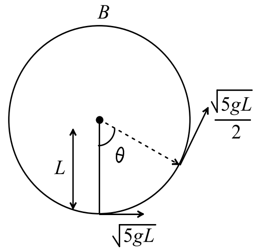
$= 50 \times \cos 30^\circ \times 2$ m

$= 100 \times \frac{2}{\sqrt{3}}$ m $= 50\sqrt{3}$m $= 86.6$ m

61 **(d)**

$V^2 = U^2 - 2g(L - L\cos\theta)$

$\frac{5gL}{4} = 5gL - 2gL(1 - \cos\theta)$

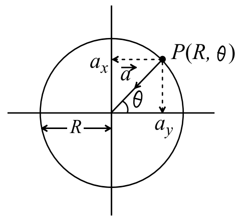


$5 = 20 - 8 + 8\cos\theta$

$\cos\theta = -\frac{7}{8}$

$\frac{3\pi}{4} < \theta < \pi$

62 **(d)**



$$\vec{a} = -\frac{v^2}{R}\cos\theta\hat{\imath} - \frac{v^2}{R}\sin\theta\hat{\jmath}$$

63 **(c)**

$\frac{v^2}{\text{g}} = 100$ or $v^2 = 100$ g

$h_{\text{max.}} = \frac{v^2}{2\text{g}} = \frac{100\text{g}}{2\text{g}} = 50$m

64 **(a)**

By doing so component of weight of vehicle provides centripetal force

65 **(b)**

$ma\cos\theta = mg\cos(90 - \theta)$

$\Rightarrow \frac{a}{g} = \tan\theta \Rightarrow \frac{a}{g} = \frac{dy}{dx}$

$\Rightarrow \frac{d}{dx}(kx)^2 = \frac{a}{g} \Rightarrow x = \frac{a}{2gk}$

66 **(a)**

$$\left|\overrightarrow{\Delta v}\right| = 2v\sin(\theta/2) = 2v\sin\left(\frac{90}{2}\right) = 2v\sin 45$$
$$= v\sqrt{2}$$

67 **(d)**

$\frac{d^2y}{dt^2} = \alpha$ and $\frac{d^2x}{dt^2} = 0$

$\frac{dy}{dt} = 2\beta x.\frac{dx}{dt}$

$$\frac{d^2y}{dt^2} = 2\beta\left[x.\frac{d^2x}{dt^2} + \left(\frac{dx}{dt}\right)^2\right]$$

$\because\ \alpha = 2\beta v_x^2$

$\therefore\ v_x = \sqrt{\frac{\alpha}{2\beta}}$

68 **(c)**

In uniform circular motion only centripetal acceleration works

69 **(d)**

Standard equation of projectile motion

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

Comparing with given equation

$A = \tan\theta$ and $B = \frac{g}{2u^2\cos^2\theta}$

So $\frac{A}{B} = \frac{\tan\theta \times 2u^2\cos^2\theta}{g} = 40$

[As $\theta = 45°, u = 20\ m/s, g = 10 m/s^2$]

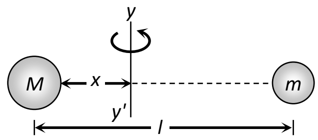
70 **(c)**

$$\omega = \frac{d\theta}{dt} = \frac{d}{dt}(2t^3 + 0.5) = 6t^2$$

At $t = 2\ s, \omega = 6 \times (2)^2 = 24\ rad/s$

71 **(b)**

If the both mass are revolving about the axis yy' and tension in both the threads are equal then



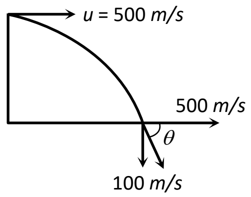
$M\omega^2 x = m\omega^2(l - x)$

$\Rightarrow Mx = m(l - x)$

$\Rightarrow x = \frac{ml}{M + m}$

72 **(a)**

Horizontal component of velocity $v_x = 500\ m/s$ and vertical components of velocity while striking the ground



$v_y = 0 + 10 \times 10 = 100\ m/s$

$\therefore$ Angle with which it strikes the ground

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) = \tan^{-1}\left(\frac{100}{500}\right) = \tan^{-1}\left(\frac{1}{5}\right)$$

73 **(b)**

$$\omega^2 R = 4\pi^2 n^2 r = 4\pi^2\left(\frac{1200}{60}\right)^2 \times 30 \times 10^{-2}$$

$$= 4732\ m/s^2$$

75 **(c)**

$A_x = 50, \theta = 60°$

Then $\tan\theta = A_y/A_x$ or $A_y = A_x\tan\theta$

Or $A_y = 50\tan 60° = 50 \times \sqrt{3} = 87$ N

76 **(c)**

Here, $v_{\max} = ?, r = 18$ m, g $= 10$ ms^{-2}

$\mu = 0.2$

$$\frac{mv_{\max}^2}{r} = F = \mu R = \mu mg$$

$v_{\max} = \sqrt{\mu rg} = \sqrt{0.2 \times 18 \times 10} = 6$ ms^{-1}

$= 6 \times \frac{18}{5}$ km h^{-1} $= 21.6$ km h^{-1}

77 **(c)**

Equation of projectile

$$y = x - \left(\frac{5}{9}\right)x^2$$

Standard equation

$$y = x\tan\theta - \frac{g}{2u^2\cos^2\theta}\cdot x^2$$

On comparing, we get

$\tan\theta = 10$

and $\frac{g}{2u^2\cos^2\theta} = \frac{5}{9}$

or $10u^2\cos^2\theta = 9g$

$g = 10$ ms^{-2}

$\therefore\ u^2\cos^2\theta = 9$

range of projecticle $R = \frac{2u^2\tan\theta\cdot\cos\theta}{g}$

$= \frac{2u^2\tan\theta\cdot\cos\theta}{g}$

$(\because \sin\theta = \tan\theta\cdot\cos\theta)$

$\frac{2(u^2\cos^2\theta)\cdot\tan\theta}{g}$

$= \frac{2 \times 9 \times 10}{10} = 18$ m

79 **(a)**

Maximum height, $H = \frac{u^2\sin^2\theta}{2g}$

Range, $R = \frac{u^2\sin 2\theta}{g}$

Given, $H = \frac{R}{2}$

$\therefore\ \frac{u^2\sin^2\theta}{2g} = \frac{u^2 2\sin\theta\cos\theta}{2g}$

or $\sin\theta = 2\cos\theta$

or $\tan\theta = 2$

or $\theta = \tan^{-1}(2)$

81 **(d)**

Kinetic energy $= \frac{1}{2}mv^2 = K = as^2$

or $mv^2 = 2as^2$

Centripetal force $= \frac{mv^2}{R} = \frac{2as^2}{R}$

82 **(c)**

Let v be the velocity of projection and θthe angle of projection

Kinetic energy at highest point

$= \frac{1}{2}mv^2\cos^2\theta$ or $E_k\cos^2\theta$

Potential energy at highest point

$= E_k - E_k\cos^2\theta = E_k(1-\cos^2\theta) = E_k\sin^2\theta$

83 **(b)**

In going from C to A, potential energy lost = potential energy gained in going from A to B

For looping the loop, minimum velocity required at B is $\sqrt{gR}$. This must be the velocity of push down initially from C

84 **(b)**

The amplitude is the radius of the circle

$R = \frac{0.8}{2} = 0.4$ m

The frequency of the shadow is the same as that of the circular motion, so

$\omega = 30$ rev/min

$= 0.5$rev/s $= \pi$ rads^{-1}

and $\mathrm{v} = \frac{\omega}{2\pi} = \frac{\pi}{2\pi} = 0.5$ Hz.

85 **(d)**

Let v the velocity of projectile at this instants. Horizontal component of velocity remains unchanged. Therefore,

$v\cos 30° = 10\cos 60°$

or $v\frac{\sqrt{3}}{2} = \frac{10}{2}$ or $v = \frac{10}{\sqrt{3}}$ ms^{-1}

86 **(d)**

At $A, v_A = \sqrt{gl}$

At $B, v_B = \sqrt{5gl}$

and at $D, v_D = \sqrt{3gl}$

Thus, $v_B > v_D > v_A$

Also, $T = 3\,mg(1+\cos\theta)$

So, $D, \theta = 90°$

$\therefore\ T = 3\,mg(1+\theta) = 3\,mg$

87 **(b)**

$$a_{resultant} = \sqrt{a_{radial}^2 + a_{tangential}^2} = \sqrt{\frac{v^4}{r^2} + a^2}$$

88 **(a)**

Given, $v = 400$ ms^{-1}, $r = 160$ m, $a = ?$

Centripetal force, $F = \frac{mv^2}{r}$

$ma = \frac{mv^2}{r}$

or $a = \frac{v^2}{r}$

So, $a = \frac{(400)^2}{160} = \frac{16\times10^4}{160}$

$= 10^3$ms^{-2} $= 1$ kms^{-2}

89 **(c)**

$F = \frac{mv^2}{r} = \frac{500\times(10)^2}{50} = 1000$N

90 **(c)**

$\mu = \frac{v^2}{rg} = \frac{(4.9)^2}{4\times9.8} = 0.61$

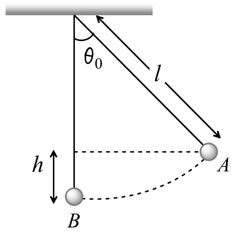
91 **(a)**

$AB\cos\theta = AB$ or $\cos\theta = 1$ or $\theta = 0°$

92 **(d)**

Maximum tension in the string is

$T_{\max} = mg + \frac{mv_B^2}{l}$



$= mg + \frac{2mgl}{l}(1-\cos\theta_0)$

$= mg + \frac{2mgl}{l}.2\sin^2\frac{\theta_0}{2}$

$\because \left(1-\cos\theta_0 = 2\sin^2\frac{\theta_0}{2}\right)$

[Since θ_0 is small]

$= mg(1+\theta_0^2)$

93 **(b)**

Let v be the velocity acquired by the body at B which will be moving making an angle 45° with the horizontal direction. As the body just crosses the well so $\frac{v^2}{g} = 40$

or $v^2 = 40g = 40\times10 = 400$

or $v = 20$ ms^{-1}

Taking motion of the body from A to B along the inclined plane we have

$u = v_0, a = -g\sin 45° = -\frac{10}{\sqrt{2}}$ms^{-2}

$s = 20$m, $v = 20$ms^{-1}

As $v^2 = u^2 + 2as$

$\therefore\ 400 = v_0^2 + 2\left(-\frac{10}{\sqrt{2}}\right)\times 20\sqrt{2}$

or $v_0^2 = 400 + 400 = 800$ or $v = 20\sqrt{2}$ms^{-1}

94 **(a)**

Work done by centripetal force in uniform circular motion is always equal to zero

95 **(c)**

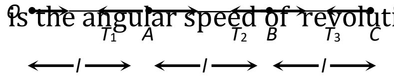
For water not to spill out of the bucket,
$v_{\min} = \sqrt{5gR}$ (at the lowest point)
$= \sqrt{5 \times 10 \times 0.5} = 5\ \text{ms}^{-1}$

96 **(d)**

$R = 4H \cot\theta$, if $\theta = 45°$ then $R = 4H \Rightarrow \frac{R}{H} = \frac{4}{1}$

97 **(d)**

Let ω is the angular speed of revolution



$T_3 = m\omega^2 3l$
$T_2 - T_3 = m\omega^2 2l \Rightarrow T_2 = m\omega^2 5l$
$T_1 - T_2 = m\omega^2 l \Rightarrow T_1 = m\omega^2 6l$
$T_3 : T_2 : T_1 = 3 : 5 : 6$

98 **(b)**

Horizontal range
$R = \frac{u^2 \sin 2\theta}{g}$ ...(i)
Maximum height
$H = \frac{u^2 \sin^2\theta}{2g}$ ...(ii)
Here (i)=(ii)

$$\frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin^2\theta}{2g}$$

$$2\cos\theta = \frac{\sin\theta}{2}$$

$\theta = \tan^{-1}(4)$

99 **(b)**

Maximum horizontal range = 80 m
$\because\ \theta = 45°$ m
$\therefore\ \frac{u^2}{g} = 80$ m

Maximum height, $h = \frac{u^2 \sin^2\theta}{2g}$

$= \frac{80}{2}(\sin^2 45°) = 20$ m

100 **(d)**

Velocity of the bob at the point A
$v = \sqrt{5gL}$ .....(i)
$\left(\frac{v}{2}\right)^2 = v^2 - 2gh$ .... (ii)
$h = L(1 - \cos\theta)$ ... (iii)
Solving Eqs. (i), (ii)and (iii), we get
$\cos\theta = -\frac{7}{8}$
or $\theta = \cos^{-1}\left(-\frac{7}{8}\right) = 151°$

101 **(d)**

Centripetal force $F = -\frac{k}{r^2}$

$\frac{mv^2}{r} = \frac{k}{r^2} \Longrightarrow mv^2 = \frac{k}{r}$

Kinetic energy $= \frac{1}{2}mv^2 = \frac{k}{2r}$
Since the centripetal force is a conservative force, and for a conservative force,

$F = \frac{dU}{dr} \Longrightarrow U = -\int F \cdot dr$

$U = \int \frac{k}{r^2} dr = -\frac{k}{r}$

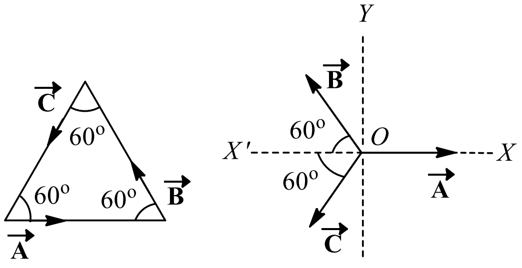
Toatal energy $= K + U = \frac{k}{2r} - \frac{k}{r} = -\frac{k}{2r}$

102 **(a)**

Given, $\omega_1 = 2\pi \times 400$ rad s^{-1}
$\omega_2 = 2\pi \times 200$ rad s^{-1}
$\therefore \alpha = \frac{2\pi(400-200)}{2} = 200\pi$ rad s^{-2}

103 **(d)**

The three vectors $\vec{A}, \vec{B}$ and $\vec{C}$ are represented as shown in figure (a) where $A = 1, B = 2$and $C = 3$. Here the sides of the equilateral triangle represent only the directions and not the magnitudes of the vectors.
In figure (b), these vector are drawn from a common point $O$and they are lying in $X - Y$ plane. Resolving these vectors into two rectangular components along X-axis and Y-axis, we have, the X-component of resultant vector as



(a) (b)

$R_X = |\vec{A}| + |\vec{B}|\cos(180° - 60°) + |\vec{C}|\cos(180° + 60°)$
$= -1 - 2\cos 60° - 3\cos 60°$
$= -1 - 2 \times \frac{1}{2} - 3 \times \frac{1}{2} = -\frac{3}{2}$
Y-component of resultant vector is
$R_Y = 0 + |\text{B}|\sin(180° - 60°) + |\vec{C}|\sin(180° + 60°)$
$= 0 + 2\sin 60° - 3\sin 60° = -\sin 60° = \sqrt{3}/2$
Magnitude of resultant vector,

$$R = \sqrt{R_X^2 + R_Y^2} = \sqrt{\left(-\frac{3}{2}\right)^2 + \left(-\frac{\sqrt{3}}{2}\right)^2}$$

$= \sqrt{3}$ units

104 **(d)**

Let u be initial velocity of projection at angle θ with the horizontal. Then, horizontal range,

$$R = \frac{u^2 \sin 2\theta}{g}$$

and maximum height $H = \dfrac{u^2 \sin 2\theta}{2g}$

Given, $R = 4\sqrt{3}H$

$\therefore \dfrac{u^2 \sin 2\theta}{g} = 4\sqrt{3} \cdot \dfrac{u^2 \sin^2\theta}{2g}$

$\therefore 2 \sin\theta \cos\theta = 2\sqrt{3}\sin^2\theta$

or $\dfrac{\cos\theta}{\sin\theta} = \sqrt{3}$

or $\cot\theta = \sqrt{3} = \cot 30°$

105 **(c)**

$\because W = FS\cos\theta \ \therefore \theta = 90^{\circ}$

106 **(c)**

In uniform circular motion, acceleration causes due to change in direction and is directed radially towards centre

107 **(d)**

The maximum speed without skidding is

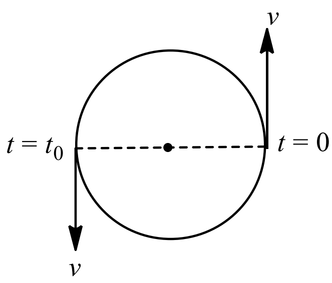
$v = \sqrt{\mu r g}$

$\therefore \dfrac{v_2}{v_1} = \sqrt{\dfrac{\mu_2}{\mu_1}} = \sqrt{\dfrac{\mu/2}{\mu}} = \dfrac{1}{\sqrt{2}}$

$v_2 = \dfrac{v_1}{\sqrt{2}} = 5\sqrt{2}\text{ms}^{-1}$

108 **(b)**

Time $T = \dfrac{2\pi r}{v}$



and $t_0 = \dfrac{T}{2} = \dfrac{\pi r}{\text{v}}$

$\therefore \text{v}_{av} = \dfrac{2r}{\pi r/\text{v}} = \dfrac{2\text{v}}{\pi}$

109 **(c)**

$V\cos\beta = v\cos\theta$

or $V = v\cos\theta\sec\beta$

110 **(b)**

$\dfrac{\omega_1}{\omega_2} = \dfrac{T_2}{T_1} = \dfrac{12\text{h}}{1\text{h}} = 12 : 1$

111 **(c)**

As, $\vec{A} \cdot \vec{B} = 0$ so $\vec{A}$ is perpendicular to $\vec{B}$. Also $\vec{A}.\vec{C} = 0$ means $\vec{A}$ is perpendicular to $\vec{C}$. Since $\vec{B} \times \vec{C}$ is perpendicular to $\vec{B}$ and $\vec{C}$, so $\vec{A}$ parallel to $\vec{B} \times \vec{C}$.

112 **(a)**

To avoid slipping friction force

$F = \dfrac{mv^2}{r}$

$F = \frac{2000\times10\times10}{20} = 10^4\text{N}$

113 **(b)**

$a^2 + b^2 + 2ab\cos\theta$

$= -a^2 + b^2 - 2ab\cos\theta$

or $4ab\cos\theta = 0$

But $4ab \neq 0 \therefore \cos\theta = 0$ or $\theta = 90°$

Again

$|\vec{a} + \vec{b}|$ and $|\vec{a} - \vec{b}|$ are the diagonals of parallelogram whose adjacent sides are $\vec{a}$ and $\vec{b}$.

Since $|\vec{a} + \vec{b}| = |\vec{a} - \vec{b}|$, therefore, the two diagonals of a parallelogram are equal. So, think of square. This leads to $\theta = 90°$.

114 **(a)**

$R_{\max} = \frac{u^2}{g} = 4\,H$ [For $\theta = 45°$]

$4H = 400 \Rightarrow H = 100\ m$

115 **(d)**

$v = r\omega = \dfrac{r \times 2\pi}{T} = \dfrac{0.06 \times 2\pi}{60} = 6.28 mm/s$

Magnitude of change in velocity $= |\overrightarrow{v_2} - \overrightarrow{v_1}|$

$= \sqrt{v_1^2 + v_2^2} = 8.88\ mm/s$[As$v_1 = v_2$

$= 6.28 mm/s$]

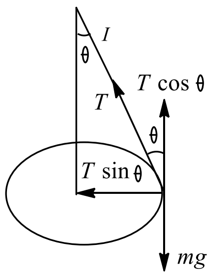
116 **(d)**

For critical condition at the highest point $\omega = \sqrt{g/R}$

$\Rightarrow T = \dfrac{2\pi}{\omega} = 2\pi\sqrt{R/g} = 2 \times 3.14\sqrt{4/9.8} = 4$ sec

117 **(d)**

As is clear from figure



$T\sin\theta = \dfrac{mv^2}{r}, T\cos\theta = mg$

Dividing, we get

$\tan\theta = \dfrac{v^2}{rg} = \dfrac{r}{\text{g}}\left(\dfrac{2\pi}{T}\right)^2$

$\dfrac{2\pi}{T} = \sqrt{\dfrac{\text{g}\tan\theta}{r}} = \sqrt{\dfrac{\text{g}\tan\theta}{l\sin\theta}} = \sqrt{\dfrac{\text{g}}{l\cos\theta}}$

or $T = 2\pi\sqrt{\frac{l\cos\theta}{\text{g}}}$

118 **(a)**

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{60} = \frac{\pi}{30}\ rad/s$$

119 **(b)**

$v = \sqrt{5gR}$

When $R' = \frac{R}{4}$

$$v' = \sqrt{5gR'} = \sqrt{5gR/4} = \frac{1}{2}\sqrt{5gR} = \frac{1}{2}v$$

120 **(d)**

Angular momentum of the projectile

$L = mv_h r_\perp$

$= m(v\cos\theta)h$

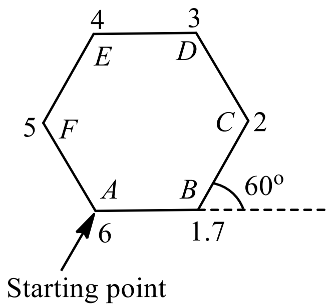
(where h is the maximum height)

$$\Rightarrow = m(v\cos\theta)\left(\frac{v^2\sin^2\theta}{2g}\right)$$

$$L = \frac{mv^3\sin^2\theta\cos\theta}{2g} = \frac{\sqrt{3}mv^3}{16g}$$

121 **(a)**

In 6 turns each of 60°, the cyclist traversed a regular hexagon path having each side 100 m. So, at 7th turn, he will be again at



Point B (as shown) which is at distance 100 m from starting point A. Hence, net displacement of cyclist is 100 m.

122 **(d)**

In a circular motion

$$a = \frac{v^2}{r} \Rightarrow \frac{a_2}{a_1} = \left(\frac{v_2}{v_1}\right)^2 = \left(\frac{2v_1}{v_1}\right)^2 = 4$$

123 **(b)**

Maximum tension in the thread is given by

$$T_{\max} = mg + \frac{mv^2}{r}$$

or $T_{\max} = mg + mrw^2 (\because v = r\omega)$

or $\omega^2 = \dfrac{T_{\max} - mg}{mr}$

Given, $T_{\max} = 37\text{ N}, \text{m} = 500\text{g} = 0.5\text{ kg}, g = \text{mg}^{-2}$,

$r = 4\text{m}$

$$\therefore\ \omega^2 = \frac{37 - 0.5\times 10}{0.5\times 4} = \frac{37-5}{2}$$

or $\omega^2 = 16$

or $\omega = 4\text{ rad s}^{-1}$

124 **(c)**

Since horizontal component of velocity is constant, hence momentum is constant

125 **(a)**

$\vec{A} = A\hat{A}$ or $\hat{A} = \frac{\vec{A}}{A}$

$\therefore$ required unit vector is $\frac{\hat{i}+\hat{j}}{|\hat{i}+\hat{j}|} = \frac{\hat{i}+\hat{j}}{\sqrt{2}}$

127 **(a)**

Max. tension that string can bear $= 3.7\ kgwt = 37\ N$

Tension at lowest point of vertical loop $= mg + m\omega^2 r$

$= 0.5\times 10 + 0.5\times\omega^2\times 4 = 5 + 2\omega^2$

$\therefore 37 = 5 + 2\omega^2 \Rightarrow \omega = 4\text{ rad/s}$

128 **(b)**

$$v_{\max} = \sqrt{\mu rg} = \sqrt{0.5\times 40\times 9.8} = 14\ m/s$$

129 **(b)**

For a particle moving in a circle with constant angular speed, velocity vector is always tangent to the circle and the acceleration vector always points towards the center of circle or is always along radius of the circle. Since, tangential vector is perpendicular to the acceleration vector. But in no case acceleration vector is tangent to the circle.

130 **(b)**

$$\frac{mv^2}{r} \propto \frac{K}{r} \Rightarrow v \propto r^o$$

i.e. speed of the particle is independent of r

131 **(c)**

Horizontal component of velocity of A is 10 cos 60° or 5 ms^{-1} which is equal to the velocity of B in horizontal direction. They will collide at C if time of flight of the particles are equal or $t_A = t_B$

$$\frac{2u\sin\theta}{g} = \sqrt{\frac{2h}{g}}\left(\because h = \frac{1}{2}gt_B^2\right)$$

or $h = \frac{2u^2\sin^2\theta}{g}$

$$= \frac{2(10)^2\left(\frac{\sqrt{3}}{2}\right)^2}{10} = 15\text{ m}$$

133 **(a)**

Horizontal velocity of aeroplane,

$$u = \frac{216\times 1000}{60\times 100} = 60\text{ ms}^{-1}$$

Time of flight, $T = \sqrt{\frac{2s}{g}} = \sqrt{\frac{2\times 1960}{9.8}} = 20\text{s}$

Horizontal range, $AB = uT$

$= 60\times 20 = 1200\text{m}$

135 **(c)**

As seen from the cart, the projectile moves

vertically upward and comes back

The time taken by cart to cover 80 m

$\frac{s}{v}=\frac{80}{30}=\frac{8}{3}\ s$

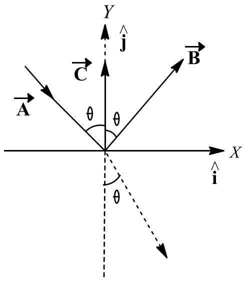
For a projectile going upward , $a=-g=-10\ m/s^2, v=0$

And $t=\frac{8/3}{2}=\frac{4}{3}\ s$

$\therefore v=u+a\,t \Rightarrow 0=u-10\times\frac{4}{3} \Rightarrow u=\frac{40}{3}\ ms^{-1}$

136 **(d)**

Let $\vec{A}, \vec{B}$ and $\vec{C}$ be as shown in figure. Let θ be the angle of incidence, which is also equal to the angle of reflection. Resolving these vectors in rectangular components, we have



$\vec{A}=\sin\theta\hat{\imath}-\cos\theta\hat{\jmath}$

$\vec{B}=\sin\theta\hat{\imath}+\cos\theta\hat{\jmath}$

$\vec{B}-\vec{A}=2\cos\theta\ \hat{\jmath}$

or $\vec{B}=\vec{A}+2\cos\theta\ \hat{\jmath}$

Now $\vec{A}.\vec{C}=2\cos\theta\hat{\jmath}$ or $\vec{B}=\vec{A}\cos\theta\ \hat{\jmath}$

$\therefore\ \ \vec{B}=\vec{A}-2(\vec{A}.\vec{C})\hat{\jmath}$ or $\vec{B}=\vec{A}-2(\vec{A}.\vec{C})\vec{C}$

(as $\hat{\jmath}=\vec{C}$)

137 **(c)**

Velocity at the lowest point, $v=\sqrt{2gl}$

At the lowest point, the tension in the string

$T=mg+\frac{mv^2}{l}=mg+\frac{m}{l}(2gl)=3mg$

139 **(a)**

$\vec{A}=2\hat{\imath}+4\hat{\jmath}, \vec{B}=5\hat{\imath}+p\,\hat{\jmath}$

$A=\sqrt{2^2+4^2}=\sqrt{20}$

$B=\sqrt{5^2+p^2}$

$\vec{A}\cdot\vec{B}=10-4p$

If $\vec{A}\parallel\vec{B}$ then

$\vec{A}\cdot\vec{B}=AB\cos 0°=AB$

$10-4p=\sqrt{20}\sqrt{25+p^2}$

Square $100+16p^2-80p$

$=20(25+p^2)=500=20p^2$

or $\ 20p^2-16p^2+80p+400=0$

or $\ \ p^2+20p+100=0$

or $\ (p+10)^2=0$

$\therefore\ \ \ p=-10$

$\therefore\ \ \vec{B}=\ 5\hat{\imath}+10\hat{\jmath}$

$B=\sqrt{5^2+(10)^2}=\sqrt{125}=5\sqrt{5}$

140 **(d)**

Range $=\frac{u^2\sin 2\theta}{g}=200\ m$

$\Rightarrow\frac{u^2(2\sin\theta\cos\theta)}{g}=200\ m$ ...(i)

Time of flight $=\frac{2u\sin\theta}{g}=5s$ ...(ii)

From equations (i) and (ii)

$u\cos\theta=40\ m/s$

141 **(a)**

Here, Mass of a stone, $m=2kg$

Length of a string, $r=0.5\ m$

Breaking tension, $T=900\ N$

As $T=mr\omega^2$ or $\omega^2=\frac{T}{mr}=\frac{900}{2\times0.5}=900$

$\omega=30\ \text{rad}s^{-1}$

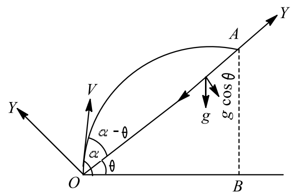
142 **(a)**

When the angle of projection is very far from 45° then range will be minimum

143 **(b)**

$v_x=v\cos(\alpha-\theta)\,; v_y=v\sin(\alpha-\theta)$

$a_x=-g\sin\theta\,; a_y=-g\cos\theta$



If T is the time of flight, then

$0=v\sin(\alpha-\theta).T-\frac{1}{2}g\cos\theta\,.T^2$

or $\ T=\frac{2v\sin(\alpha-\theta)}{g\cos\theta}$

$OB=v\cos\alpha\times T$

Now, $\cos\theta=\frac{OB}{OA}$ or $OA=\frac{OB}{\cos\theta}$

or $OA=\frac{v\sin\alpha T}{\cos\theta}$

or $OA=v\cos\alpha\times\frac{2v\sin(\alpha-\theta)}{g\cos\theta}\times\frac{1}{\cos\theta}$

or $OA=\frac{v^2}{g\cos^2\theta}[\sin(2\alpha-\theta)\cos\alpha]$

or $OA=\frac{v^2}{g\cos^2\theta}[\sin(2\alpha-\theta)+\sin(-\theta)]$

or $OA=\frac{v^2}{g\cos^2\theta}[\sin(2\alpha-\theta)-\sin\theta]$

Clearly, the range $R(=OA)$ will be maximum when sin $(2a-\theta)$ is maximum, ie, 1.

This would mean

$2\,\alpha-\theta=\frac{\pi}{2}$ or $\alpha\ \frac{\theta}{2}+\frac{\pi}{4}$

Maximum range up the inclined plane,

$R_{\max}=\frac{v^2}{g\cos^2\theta}(1-\sin\theta)=\frac{v^2(1-\sin\theta)}{g(1-\sin^2\theta)}$

$$= \frac{v^2(1-\sin\theta)}{g(1-\sin\theta)(1+1-\sin\theta)} = \frac{v^2}{g(1+\sin\theta)}$$

144 **(d)**

Tension at the top of the circle, $T = m\omega^2 r - mg$

$T = 0.4 \times 4\pi^2 n^2 \times 2 - 0.4 \times 9.8 = 122.2N$

$\approx 115.86N$

145 **(d)**

In non-uniform circular motion particle possess both centripetal as well as tangential acceleration

147 **(a)**

Here, $r = 7$ m, $v = 5$ ms^{-1}, $\theta = ?$

$$\tan\theta = \frac{v^2}{rg} = \frac{5\times 5}{7\times 9.8} = 0.364$$

$\theta = \tan^{-1}(0.364) = 20°$

148 **(c)**

Time of flight. $T = \frac{2u\sin\theta}{g}$

Horizontal range, $R = \frac{u^2\sin 2\theta}{g}$

Change in angular momentum,

$|d\vec{\mathbf{L}}| = |\vec{\mathbf{L}}_f - \vec{\mathbf{L}}_i|$ about point of projection

$$= (mu\sin\theta) \times \frac{u^2\sin 2\theta}{g}$$

$$= \frac{mu^3\sin\theta\sin 2\theta}{g}$$

Torque $|\vec{\tau}| = \frac{\text{change in angular momentum}}{\text{time of flight}}$

$$= \left|\frac{d\vec{\mathbf{L}}}{T}\right|$$

149 **(c)**

When two bullets are fired simultaneously, horizontally with different speeds, then they cover different horizontal distance because there is no acceleration in this direction.

Since, horizontal distance(R) = velocity $\times$ time.

But there is a vertical acceleration towards the earth (g), so the vertical distance covered by both bullet are

given by

$y = \frac{1}{2}gt^2$, which is independent of initial velocity.

So, both the bullets will hit the ground simultaneously .

150 **(d)**

$T = mg + m\omega^2 r = m\{g + 4\pi^2 n^2 r\}$

$$= m\left\{g + \left(4\pi^2\left(\frac{n}{60}\right)^2 r\right)\right\} = m\left\{g + \left(\frac{\pi^2 n^2 r}{900}\right)\right\}$$

151 **(c)**

$$h = v\sin\theta\, t - \frac{1}{2}gt^2$$

or $\frac{1}{2}gt^2 - v\sin\theta\, t + h = 0$

$$t_1 + t_2 = -\frac{-v\sin\theta}{\frac{1}{2}g} \text{ or } t_1 + t_2 = \frac{2v\sin\theta}{g} = T$$

or $T = (1+3)\text{s} = 4\text{s}$

152 **(b)**

We know, $F = mr\omega^2$

$r\omega^2$ =constant

$$\omega^2 \propto \frac{1}{r}$$

$$\left(\frac{\omega_2}{\omega_1}\right)^2 = \frac{r_1}{r_2}$$

$\frac{4\omega_1^2}{\omega_1^2} = \frac{8}{r_2}$ $\quad \therefore r_2 = 2$ cm

153 **(b)**

Due to air resistance, it's horizontal velocity will decrease so it will fall behind the aeroplane

154 **(a)**

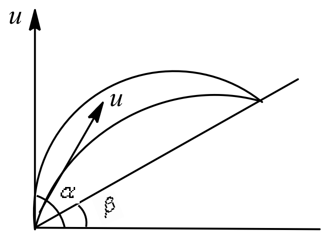
When particle moves in a circle, then the resultant force must act towards the centre and its magnitude F must satisfy, $F = \frac{mv^2}{l}$

This resultant force is directed towards the centre and it is called centripetal force. This force originates from the tension T

Hence, $F = \frac{mv^2}{l} = T$

155 **(d)**

Let α'' be the angle of projection of the second body



$$R = \frac{u^2}{g\cos\beta}[\sin(2\alpha - \beta)]$$

Range of both the bodies is same. Therefore,

$\sin(2\alpha - \beta) = \sin(2\alpha'' - \beta)$

or $2\alpha'' - \beta = \pi - (2\alpha - \beta)$

$$\alpha'' = \frac{\pi}{2} - (\alpha - \beta)$$

Now, $T = \frac{2u\sin(\alpha-\beta)}{g\cos\beta}$ and $T'' = \frac{2u\sin(\alpha''-\beta)}{g\cos\beta}$

$$\therefore \frac{T}{T''} = \frac{\sin(\alpha-\beta)}{\sin(\alpha''-\beta)} = \frac{\sin(\alpha - \beta)}{\sin\left\{\frac{\pi}{2} - (\alpha - \beta) - \beta\right\}}$$

$$= \frac{\sin(\alpha - \beta)}{\sin\left(\frac{\pi}{2} - \alpha\right)} = \frac{\sin(\alpha - \beta)}{\cos\alpha}$$

156 **(c)**

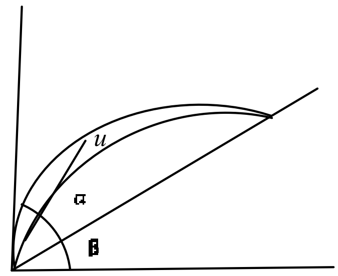
Resultant acceleration

$$= \sqrt{\begin{pmatrix}\text{tangential}\\ \text{acceleration}\end{pmatrix}^2 + \begin{pmatrix}\text{centripetal}\\ \text{acceleration}\end{pmatrix}^2}$$

$$= \sqrt{a^2 + \left(\frac{v^2}{r}\right)^2} = \sqrt{\frac{v^4}{r^2} + a^2}$$

157 **(b)**

Let α' be the angle of projection of the second body



$$R = \frac{u^2}{g\cos^2\beta}[\sin(2\alpha - \beta) - \sin\beta]$$

Range of both the body is same. Therefore

$\sin(2\alpha - \beta) = \sin(2\alpha' - \beta)$

or $2\alpha' - \beta = \pi - (2\alpha - \beta)$

$$\alpha' = \frac{\pi}{2} - (\alpha - \beta)$$

Now, $T = \dfrac{2u\sin(\alpha - \beta)}{g\cos\beta}$ and $T' = \dfrac{2u\sin(\alpha' - \beta)}{g\cos\beta}$

$$\therefore \frac{T}{T'} = \frac{\sin(\alpha - \beta)}{\sin(\alpha' - \beta)} = \frac{\sin(\alpha - \beta)}{\sin\left\{\frac{\pi}{2} - (\alpha - \beta) - \beta\right\}}$$

$$\frac{\sin(\alpha - \beta)}{\sin\left(\frac{\pi}{2} - \alpha\right)} = \frac{\sin(\alpha - \beta)}{\cos\alpha}$$

158 **(d)**

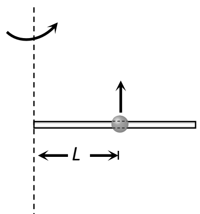
Time period $= 40\ sec$

No. of revolution $= \frac{\text{Total time}}{\text{Time period}} = \frac{140\text{ sec}}{40\text{ sec}} = 3.5\ Rev.$

So, distance $= 3.5 \times 2\pi R = 3.5 \times 2\pi \times 10 = 220m$.

159 **(a)**

Let the bead starts slipping after time t



For critical condition Frictional force provides the centripetal force

$m\omega^2 L = \mu R = \mu m \times a_t = \mu L m\alpha$

$\Rightarrow m(\alpha t)^2 L = \mu m L\alpha$

$\Rightarrow t = \sqrt{\frac{\mu}{\alpha}}$ [As $\omega = \alpha t$]

160 **(b)**

On a circular path in completing one turn, the distance traveled is $2\pi r$ while displacement is zero.

Hence, average velocity $= \dfrac{\text{displacement}}{\text{time interval}} = \dfrac{0}{t} = 0$

Average speed $= \dfrac{\text{distance}}{\text{time interval}}$

$$= \frac{2\pi r}{t} = \frac{2 \times 3.14 \times 100}{62.8} = 10\text{ ms}^{-1}$$

161 **(b)**

$$F = \frac{mv^2}{r} = \frac{500 \times 100}{50} = 10^3\ N$$

162 **(a)**

Time to reach max. height $= t_m$

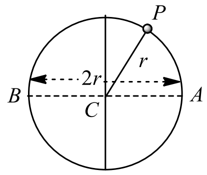
Time to reach back to ground $= t_m$

Total time of flight $T_f = t_m + t_m$

$T_f = 2t_m$

163 **(b)**

Angular velocity about $A, \omega_1 = v/2r$



Angular velocity about, $\omega_1 = v/2r$

$\therefore\ \omega_1/\omega_2 = (v/2r)/(v/r) = 1/2$

164 **(c)**

They have same ω

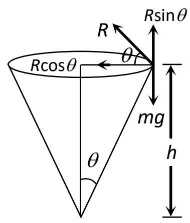
Centripetal acceleration $= \omega^2 r$

$$\frac{a_1}{a_2} = \frac{\omega^2 r_1}{\omega^2 r_2} = \frac{r_1}{r_2}$$

165 **(d)**

Minimum speed at the highest point of vertical circular path $v = \sqrt{gR}$

166 **(d)**



The particle is moving in circular path

From the figure, $mg = R\sin\theta$ ... (i)

$$\frac{mv^2}{r} = R\cos\theta \qquad \text{... (ii)}$$

From equation (i) and (ii) we get

$\tan\theta = \frac{rg}{v^2}$ but $\tan\theta = \frac{r}{h}$

$$\therefore h = \frac{v^2}{g} = \frac{(0.5)^2}{10} = 0.025m = 2.5\ cm$$

167 **(a)**

$$\tan\theta = \frac{h}{b} = \frac{v^2}{rg},$$

$$v = \sqrt{\frac{hrh}{b}} = \sqrt{\frac{1.5 \times 50 \times 10}{10}} = 8.5\ \text{ms}^{-1}$$

169 **(a)**

Minimum tension $T_1 = \dfrac{mv^2}{r} - mg$

Maximum tension $T_2 = \dfrac{mv^2}{r} + mg$

Let $\dfrac{mv^2}{r} = x$

So, $T_1 = x - mg$ ...(i)

$T_2 = x + mg$ ...(ii)

Diving Eq. (i) by Eq. (ii)

$\dfrac{T_1}{T_2} = \dfrac{x - mg}{x + mg} \left(\because \text{Given} \dfrac{T_1}{T_2} = \dfrac{3}{5} \right)$

$\therefore \dfrac{3}{5} = \dfrac{x - mg}{x + mg}$

or $3x + 3mg = 5x - 5mg$

or $x = 4\,mg$

$ie, \dfrac{mv^2}{r} = 4mg$

$\therefore \quad v^2 = 4\,rg$

or $\quad v = \sqrt{4rg}$

or $v = \sqrt{4 \times 2.5 \times 9.8}$

$v = \sqrt{98}\text{ms}^{-1}$

170 **(c)**

Angular momentum $L = r \times p = r \times m \times v$

$v = \dfrac{L}{mr} \quad \ldots.(\text{i})$

Now, as centripetal force, $F_c = \dfrac{mv^2}{r} \quad \ldots.(\text{ii})$

Substituting the value of v from Eq. (i) in Eq. (ii), we get

$$F_c = \frac{m}{r}\left[\frac{L}{mr}\right]^2 = \frac{L^2}{mr^3}$$

171 **(b)**

$F^2 = F^2 + F^2 + 2F^2\cos\theta$

or $\quad F^2 = 2F^2(1 + \cos\theta)$

or $\quad 1 + \cos\theta = \frac{1}{2}$

or $\quad \cos\theta = -\frac{1}{2}$ or $\theta = 120°$

$\therefore \cos 120° = -\dfrac{1}{2}$

172 **(c)**

The result follows from the definition of cross product.

173 **(a)**

$$t = \sqrt{\frac{2 \times 2000}{10}} = \sqrt{400} = 20\ \text{s}$$

$x = 100\text{ms}^{-1} \times 20\text{s} = 2000\ \text{m} = 2\text{km}$

174 **(b)**

New kinetic energy $E' = E = \cos^2\theta$

$= E\cos^2(45°)$

$\dfrac{E}{2}$

175 **(c)**

When the force acting on a body is directed towards a fixed point, then it changes only the direction of motion of the body without changing its speed. So, the particle will describe a circular motion

176 **(a)**

$25 = 0.25 \times v^2/1.96$

or $v = (25 \times 1.96/0.25)^{1/2} = 5 \times \frac{14}{5} = 14\text{ms}^{-1}$

177 **(b)**

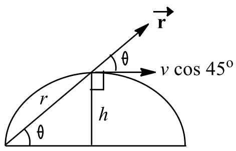
Only horizontal component of velocity $(u\cos\theta)$

178 **(b)**

The angular momentum of a particle is given by

$\vec{\mathbf{L}} = \vec{\mathbf{r}} \times m\vec{\mathbf{v}}$

$L = mvr\sin\theta$



From figure,

$L = rm(v\cos 45°)\sin\theta$

$= \dfrac{mv}{\sqrt{2}}(r\sin\theta)$

$= \dfrac{mvh}{\sqrt{2}}\left(\because \ \sin\theta = \dfrac{h}{r}\right)$

179 **(b)**

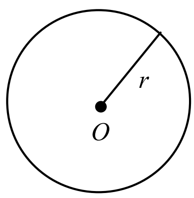
The time taken by the particle for one complete revolution.

$t = \dfrac{2\pi r}{\text{speed}}$

$= \dfrac{2 \times 3.14 \times 100}{31.4} = 20\text{s}$

Hence, averge speed is

$v_{\text{av}} = \dfrac{2 \times 3.14 \times 100}{20} = 31.4\ \text{ms}^{-1}$



180 **(b)**

$R_{\max} = \dfrac{u^2}{g} = \dfrac{(20)^2}{10} = 40\ m$

181 **(a)**

Time period of earth on its own axis

$T = 24$ h
$= 24 \times 60 \times 60$ s
$\therefore$ Angular velocity $\omega = \frac{2\pi}{T}$
$= \frac{2\pi}{24 \times 60 \times 60}$
$= \frac{2\pi}{86400}$ rads^{-1}

182 **(d)**
When the string makes an angle θ with the vertical, then
$T - mg\cos\theta = \frac{mv^2}{r}$
Substituting the values, we obtain
$6 - (1)(10)\cos\theta = \frac{1 \times (4)^2}{1}$
or $6 - 10\cos\theta = 16$
or $\cos\theta = -1 = \cos 180°$
$\therefore = 180°$

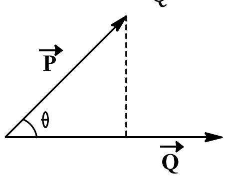
183 **(c)**
$\mu = \frac{v^2}{rg} = \frac{(60 \times 5/18)^2}{40 \times 9.8} = 0.71$

184 **(a)**
Minimum speed at the lowest point
$= \sqrt{5rg} = \sqrt{5 \times 5 \times 9.8} = 15.65$ ms^{-1}

185 **(d)**
Net displacement in one loop = 0
Average velocity $= \frac{\text{net displacement}}{\text{time}} = \frac{0}{t} = 0$
Distance travelled in one rotation (loop) $= 2\pi r$
$\therefore$ Average speed $= \frac{\text{distance}}{\text{time}} = \frac{2\pi r}{t}$
$= \frac{2 \times 3.14 \times 100}{62.8} = 10 m/s.$

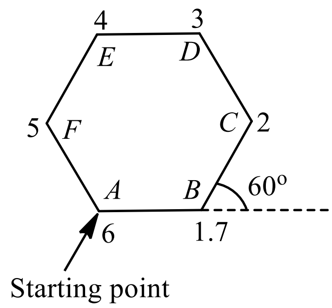
187 **(c)**
If v is velocity of the bob on reaching the lowest point, then $\frac{1}{2}mv^2 = mgL$
To void breaking, strength of the string
$T_L = \frac{mv^2}{L} + mg = \frac{2mg\,L}{L} + mg = 3\,mg$

188 **(b)**
Projection of $\vec{P}$ on $\vec{Q}$ is $P\cos\theta$
$P\cos\theta = \frac{PQ\cos\theta}{Q} = \frac{\vec{P}\cdot\vec{Q}}{Q} = \vec{P}\cdot\vec{Q}$



189 **(a)**
When speed is constant in circular motion, it means work done by centripetal force is zero

190 **(a)**
In 6 turns each of 60°, the cyclist traversed a regular hexagon path having each side 100 m. So, at 7th turn, he will be again at



Point B (as shown) which is at distance 100 m from starting point A. Hence, net displacement of cyclist is 100 m.

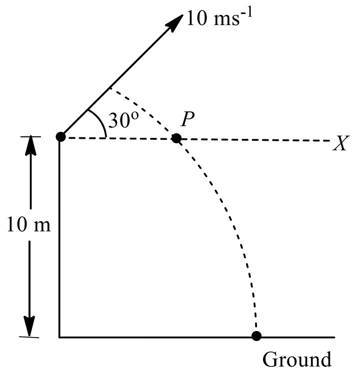
191 **(a)**
$T = m\omega^2 r \Rightarrow \omega \propto \sqrt{T} \therefore \frac{\omega_2}{\omega_1} = \sqrt{\frac{1}{4}} \Rightarrow \omega_2 = \frac{\omega_1}{2}$
$= 5\,rpm$

192 **(b)**
Increment in angular velocity $\omega = 2\pi(n_2 - n_1)$
$\omega = 2\pi(1200 - 600)\frac{rad}{min} = \frac{2\pi \times 600}{60}\frac{rad}{s}$
$= 20\pi\frac{rad}{s}$

193 **(d)**
$\mathbf{L} = m(\mathbf{r} \times \mathbf{v})$
Direction of $(\mathbf{r} \times \mathbf{v})$, hence the direction of angular momentum remains the same.

196 **(c)**
Given condition $h_1 = h_2$
$u_1^2\sin^2 45° = u_2^2\sin^2\theta$
$\sin^2\theta = \frac{u_1^2}{u_2^2}\sin^2 45°$
$= \frac{1}{2}\cdot\frac{1}{2} = \frac{1}{4}$
$\sin\theta = \frac{1}{2} \Longrightarrow \theta = 30°$

197 **(d)**
The ball will be at point P when it is at height of 10 m from the ground. So, we have to find distance OP, whichcan be calculated by directly considering it as a projectile on a level (OX).



$$OP = R = \frac{u^2 \sin 2\theta}{g}$$

$$= \frac{10^2 \sin(2 \times 30°)}{10}$$

$$= \frac{10\sqrt{3}}{2} = 5\sqrt{3}$$

$$= 8.66 \text{ m}$$

198 **(c)**

Tension in the string

$T = mv^2/r = (r\omega)^2 = mr\omega^2$

If $r_1 = r/2$ and $\omega_1 = 2\omega$, then

$T_1 = m(r/2)(2\omega)^2 = 2mr\omega^2 = 2T$

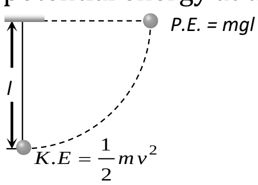
199 **(c)**

Here, $h = \frac{u^2 \sin^2\theta}{2g}$ or $\sqrt{\frac{2h}{g}} = \frac{u \sin\theta}{g}$

Time of flight, $T = \frac{2u \sin\theta}{g} = 2\sqrt{\frac{2h}{g}}$

200 **(d)**

Kinetic energy given to a sphere at lowest point = potential energy at the height of suspension



$$\Rightarrow \frac{1}{2}mv^2 = mgl$$

$$\therefore v = \sqrt{2gl}$$

201 **(c)**

Suppose t_0 be the time to reach maximum height in the absence of air resistance, then from the relation

$t_0 = \frac{u \sin\alpha}{g}$ ...(i)

When a is retardation caused by air resistance, then total retardation will be $g + a$

$t_1 = \frac{u \sin\alpha}{g+a} = \frac{u \sin\alpha}{g + \left(\frac{1}{10}\right)g} = \frac{10u \sin\alpha}{11g}$...(ii)

Now from equations (i) and (ii), we have

$$\therefore t_1 = \frac{10}{11}t_0 \Rightarrow t_0 - t_1 = t_0 - \frac{10}{11}t_0 = \frac{1}{11}t_0$$

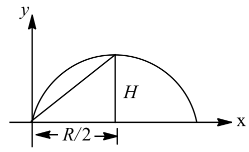
$$= 0.09\, t_0$$

$\therefore$ Time will decrease by 9%

202 **(c)**

Average velocity $= \frac{\text{displacement}}{\text{time}}$

$V_{av} = \frac{\sqrt{H^2 + \frac{R^2}{4}}}{T/2}$ ....(i)



Here H =maximum height $= \frac{v^2 \sin^2\theta}{2g}$

R =range $= \frac{v^2 \sin 2\theta}{g}$

and T =time of flight $= \frac{2v \sin\theta}{g}$

Substituting in Eq. (i), we get

$v_{av} = \frac{v}{2}\sqrt{1 + 3\cos^2\theta}$

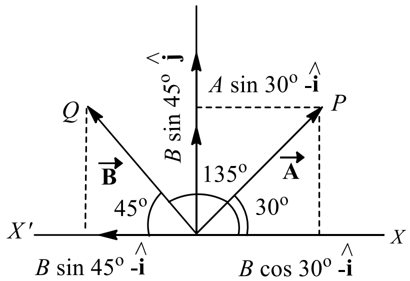
203 **(a)**

Here $\vec{A} - \overrightarrow{OP} = 10$ units along OP

$\vec{B} - (\overrightarrow{OQ}) = 10$ units along OQ

$\therefore \quad \angle XOP = 30°$ and $\angle XOQ = 135°$

$\therefore \quad \angle QOX' = 180° - 135° = 45°$



Resolving $\vec{A}$ and $\vec{B}$ into two rectangular components we have A cos 30° along OX and A sin 30° along OY. B cos 45° along OX' and B sin 45° along OY'.

Resultant component force along X-axis.

$(A \cos 30° - B \sin 45)\hat{i}$

$= (10 \times \sqrt{3}/2 - 10 \times 1/\sqrt{2})\hat{i} = 1.59\hat{i}$

Resultant component force along Y-axis

$= (A \sin 30° + B \sin 45°)\hat{j}$

$= (10 \times 1/2 + 10 \times 1/\sqrt{2})\hat{j} = 12.07\hat{j}$

204 **(b)**

When a particle moves in a circular motion, it is acted upon by centripetal force directed towards the centre. Hence, centripetal acceleration is

$$a_N = \frac{dv}{dt} = \frac{v^2}{R}$$

or $\int_0^t \frac{dt}{R} = \int_{v_0}^{v} \frac{dv}{v^2}$

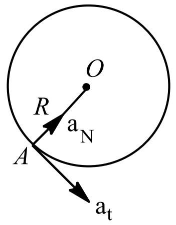
or $t = -R\left[\frac{1}{v}\right]_{v_0}^{v}$

$v = \frac{v_0 R}{R - v_0 t}$

Also $\frac{dr}{dt} = \frac{v_0 R}{(R - v_0 t)}$

$\int_0^{2\pi\ R} dr = v_0 R \int_0^{T} \frac{dt}{R - v_0 t}$

$\Rightarrow \quad T = \frac{R}{v_0}(1 - 1 - e^{-2\pi})$



205 **(c)**

Tension = Centrifugal force + weight $= \frac{mv^2}{r} + mg$

206 **(b)**

Angular speed of minute hand,

$\omega_m = \frac{2\pi}{60\times60}$ rad s^{-1}

Angular speed of hour hand,

$\omega_h = \frac{2\pi}{12\times60\times60}$ rad s^{-1}

$\therefore \frac{\omega_m}{\omega_h} = 12$

207 **(b)**

Here, $r = 100$ m, $t = 62.8$ s

In one circular loop, displacement = 0

$\therefore$ Velocity=0

Distance traveled $=2\pi r$

$\therefore$ Speed $= \frac{2\pi r}{t} = \frac{2.14\times100}{62.8} = 10$ ms^{-1}

208 **(d)**

$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times396.9}{9.8}} \simeq 9$ sec and $u =$ $720 km/hr = 200\ m/s$

$\therefore R = u \times t = 200 \times 9 = 1800\ m$

209 **(b)**

$F = \frac{mv^2}{r} \Rightarrow F \propto v^2$. If v becomes double then F(tendency to overturn) will become four times

210 **(c)**

$T =$ tension, $W =$ weight and F = centrifugal force

211 **(b)**

$h = 145 - 22.5 = 122.5$ m

Now, $40 = v\sqrt{\frac{2\times122.5}{9.8}}$

or $40 = v \times 5$ or $v = 8$ ms^{-1}

212 **(c)**

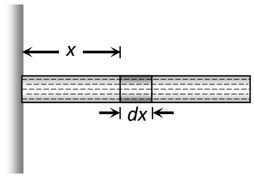
Frequency of wheel, $v = \frac{300}{60} = 5$ rps. Angle described by wheel in one rotation $= 2\pi$ rad. Therefore, angle described by wheel in 1 s $= 2\pi \times 5$ rad $= 10\pi$ rad

213 **(a)**

$dM = \left(\frac{M}{L}\right) dx$

Force on $'dM'$ mass is

$dF = (dM)\omega^2 x$



By integration we can get the force exerted by whole liquid

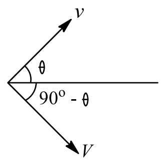
$\Rightarrow F = \int_0^L \frac{M}{L}\omega^2 x\, dx = \frac{1}{2} M\omega^2 L$

214 **(d)**

Equating horizontal components, we get

$V\cos(90° - \theta) = v\cos\theta$

or $V\sin\theta = v\cos\theta$ or $V = v\cot\theta$



215 **(d)**

Angular velocity of second's hand

$= \frac{2\pi}{60} = \frac{\pi}{30} = \frac{3.14}{30}$

$= 0.1047$ rad s^{-1}

Linear velocity, $v = r\omega$

$= 3 \times 10^{-2} \times 0.1047 = 0.00314$ ms^{-1}

216 **(b)**

Due to centrifugal force

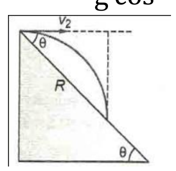
217 **(a)**

Range of the projectile on an inclined plane (down the plane) is,

$R = \frac{u^2}{g\cos^2\beta}[\sin(2\alpha + \beta) + \sin\beta]$

Here, $u = v_0, \alpha = 0$ and $\beta = \theta$

$\therefore R = \frac{2v_0^2 \sin\theta}{g\cos^2\theta}$



Now $x = R\cos\theta = \frac{2v_0^2 \tan\theta}{g}$

and $y = -R\sin\theta = -\frac{2v_0^2 \tan^2\theta}{g}$

218 **(d)**

$T\sin\theta = M\omega^2 R$...(i)

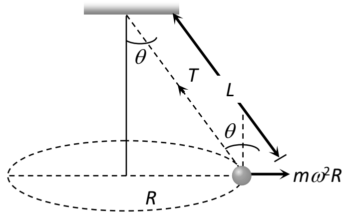
$T\sin\theta = M\omega^2 L\sin\theta$ ...(ii)

From (i) and (ii)

$T = M\omega^2 L$

$= M\,4\pi^2 n^2 L$

$= M\,4\pi^2\left(\frac{2}{\pi}\right)^2 L = 16\,ML$



219 **(a)**

For particle P, motion between A and C will be an accelerated one while between C and B a retarded one. But in any case horizontal component of it's velocity will be greater than or equal to v on the other hand in case of particle Q, it is always equal to v. Horizontal displacement of both the particles are equal, so $t_P < t_Q$

220 **(c)**

Velocity at the lowest point

$v = \sqrt{2gl}$

At the lowest point, the tension in the string

$$T = mg + \frac{mv^2}{l}$$

$$= mg + \frac{m}{l}(2gl) = 3\,mg$$

221 **(b)**

One circular motion, the force acts along the radius and displacement at a location is perpendicular to the radius $ie, \theta = 90°$

As work done $= \vec{\mathbf{F}}\cdot\vec{\mathbf{s}} = Fs\cos 90° = 0$

222 **(d)**

$$h_{\text{max.}} = \frac{v^2\sin^2\theta}{2g}$$

In the given problem, $h_{\text{max.}}$ is same in both the cases

$\therefore\ v_1^2\sin^2 60° = v_2^2\sin^2 30°$

or $\frac{v_1}{v_2} = \frac{\sin 30°}{\sin 60°} = \frac{1}{2}\times\frac{2}{\sqrt{3}} = \frac{1}{\sqrt{3}}$

223 **(a)**

Here, $v = 900\text{ km h}^{-1}$

$$= \frac{900\times 1000}{60\times 60}\text{ms}^{-1} = 250\text{ ms}^{-1}$$

Minimum force is at the bottom of the vertical circle

$$F_{\text{max}} = \frac{mv^2}{r} + mg = 5\,mg$$

$\therefore\ v^2 = 4\,gr$

or $r = \frac{v^2}{4g} = \frac{250\times 250}{4\times 980} = 1594\text{ m}$

224 **(a)**

Kinetic energy

$$E = \frac{1}{2}mv^2$$

or $\frac{1}{2}mr\frac{v^2}{r} = E$

or $\frac{1}{2}mra = E$

or $a = \frac{2E}{mr}$

225 **(d)**

Centripetal force, $F = \frac{mv^2}{r}$

$$v = \sqrt{\left(\frac{rF}{m}\right)} = \sqrt{\frac{0.5\times 10\times 1000}{100}}$$

$= \sqrt{50}\text{ms}^{-1} = 7.07\text{ms}^{-1}$

226 **(d)**

As maximum value of $T = mg$ from $2T\cos\theta = mg$.

$2\cos\theta = 1, \cos\theta = \frac{1}{2}, \theta = 60°$

Angle between two arms $= 2\theta = 120°$

227 **(b)**

Since, acceleration is constant

$$\therefore\ \vec{\mathbf{s}} = \vec{\mathbf{u}} + \frac{1}{2}\vec{\mathbf{a}}t^2$$

$$= (2\hat{\imath} - 4\hat{\mathbf{j}})t + \frac{1}{2}(3\hat{\mathbf{i}} + 5\hat{\mathbf{j}})t^2$$

$$= (2\hat{\mathbf{i}} - 4\hat{\jmath})2 + \frac{1}{2}(3\hat{\mathbf{i}} + 5\hat{\mathbf{j}})2^2$$

$= 10\hat{\mathbf{i}} + 2\hat{\mathbf{j}}$

$|\vec{\mathbf{s}}| = \sqrt{10^2 + 2^2} = \sqrt{104} = 10.2\text{m}$

228 **(b)**

Here, $m = 5\text{ kg}, r = 2\text{m}, v = 6\text{ ms}^{-1}$

The tension is maximum at the lowest point

$$T_{\text{max}} = mg + \frac{mv^2}{r}$$

$$= 5\times 9.8 + \frac{5\times 6\times 6}{2}$$

$= 139\text{N}$

229 **(c)**

Maximum height, $H = \frac{u^2\sin^2\theta}{2g}$

Time of flight, $T = \frac{2u\sin\ \theta}{g}$

$$\therefore\ \frac{H}{T^2} = \frac{u^2\sin^2\theta/2g}{4u^2\sin^2\theta/g^2} = \frac{g}{8} = \frac{10}{8} = \frac{5}{4}$$

230 **(c)**

$v = r\omega \Rightarrow \omega = \frac{v}{r}$ = constant [As v and r are constant]

231 **(a)**

When particle moves in circle, then the resultant force must act towards the center and its magnitude F must satisfy

$$F = \frac{mv^2}{l}$$

This resultant force is directed towards the center and it is called centripetal force. This force originates form tension T.

$$\therefore F = \frac{mv^2}{l} = T$$

232 **(b)**

Change in momentum $= 2mv\sin\theta = 2mv\sin\frac{\pi}{4} = \sqrt{2}mv$

233 **(c)**

At the topmost point of the projectile there is only horizontal component of velocity and acceleration due to gravity is vertically downward, so velocity and acceleration are perpendicular to each other.

234 **(d)**

Given, $x = 0.20$ m, $y = 0.20$ m, $u = 1.8\text{ms}^{-1}$

Let the ball strike the nth step of stairs,

Vertical distance travelled

$$= ny = n \times 0.20 = \frac{1}{2}gt^2$$

Horizontal distance travelled, $nx = ut$

$$\text{or } t = \frac{nx}{u}$$

$$\therefore ny = \frac{1}{2}g \times \frac{n^2x^2}{u^2}$$

$$\text{or } n = \frac{2u^2}{g}\frac{y}{x^2} = \frac{2 \times (1.8)^2 \times 0.20}{9.8 \times (0.20)^2}$$

$$= 3.3 = 4$$

235 **(a)**

Initial angular velocity $\omega_0 = 0$. Final angular velocity $\omega = \frac{v}{r} = \frac{80}{(20/\pi)} = 4\pi$ rad s^{-1}

angle described, $\theta = 4\pi$ rad

$\therefore$ Angular acceleration, $\alpha = \frac{\omega^2 - \omega_0^2}{2\theta}$

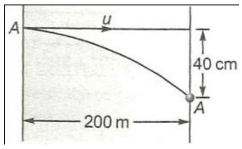
$= \frac{(4\pi)^2 - 0}{2 \times 4\pi} = 2\pi$ rad s^{-2}

Linear acceleration, $a = \alpha r$

$$= 2\pi \times \frac{20}{\pi} = 40 \text{ ms}^{-2}$$

237 **(d)**

$200 = ut$



or $t = 200/u$

Also, $\frac{40}{100} = \frac{1}{2} \times 9.8\left(\frac{200}{u}\right)^2$

On solving $u = 700 \text{ ms}^{-1}$

238 **(c)**

Here, $m = 2$ kg, $r = 1$ m, $v = 4 \text{ ms}^{-1}$

Tension at the bottom of the circle,

$$T_L = mg + \frac{mv^2}{r}$$

$$= 2 \times 10 + \frac{2 \times 4^2}{1} = 52\text{N}$$

239 **(c)**

When a stone tied at the end of string is rotated in a circle, the velocity of the stone at an instant acts tangentially outwards the circle. When the string is released, the stone files off tangentially outwards *ie*, in the direction of velocity

240 **(c)**

Centripetal acceleration $= 4\pi^2n^2r = 4\pi^2\left(\frac{1}{2}\right)^2 \times 4 = 4\pi^2$

241 **(b)**

$$H = \frac{v^2\cos^2\beta}{2g} \text{ or } v\cos\beta = \sqrt{2gH}$$

$$t = \frac{v\cos\beta}{g} = \frac{\sqrt{2gH}}{g} \text{ or } t = \sqrt{\frac{2H}{g}}$$

242 **(b)**

Angular momentum $\vec{L} = \vec{r} \times \vec{p}$

$= (2\hat{i} + 2\hat{j} + \hat{k}) \times (2\hat{i} - 2\hat{j} + \hat{k}) = 4\hat{i} - 8\hat{k}$

244 **(c)**

Given that, radius of circle, $r = 30\text{cm} = 0.3\text{m}$

linear speed $v = 2t$

Now, radial acceleration $a_R = \frac{v^2}{r} = \frac{(2t)^2}{0.3}$

at $t = 3s$

$$a_R = \frac{(2 \times 3)^2}{0.3}$$

$$\frac{36}{0.3} = 120\text{ms}^{-2}$$

or $a_R = 120\text{ms}^{-2}$

and tangential acceleration $a_T = \frac{dv}{dt} = \frac{d}{dt}(2t)$

$$= 2\text{ms}^{-2}$$

245 **(c)**

In a vertical circular motion, centripetal force remains same at all points on circular path and always directed towards the centre of circular

path

246 **(d)**

Acceleration $a = \alpha x^2 \Rightarrow \frac{dV}{dt} = \alpha x^2$

$\Rightarrow dV = \alpha x^2 dt \Rightarrow dV = \alpha x^2 dx \frac{dt}{dx}$

$\Rightarrow \int_0^{v_0} V dV = \int_0^x \alpha x^2 dx \Rightarrow \frac{V_0^2}{2} = \frac{\alpha . x^3}{3}$

$\Rightarrow x = \left[\frac{3V_0^2}{2\alpha}\right]^{-1/3}$

247 **(c)**

The velocity of the particle at any time t

$\vec{\mathbf{v}} = \vec{\mathbf{v}}0 + \vec{\mathbf{a}}t$

The x-component is

$v_x = v_{ax} + a_x t$

The y-component is

$v_y = v_{ay} + a_x = (-0.5t)\text{ms}^{-1}$

When the particle reaches its maximum x-coordinates, $v_x = 0$. That is

$3 - t = 0$

$\Rightarrow t = 3\text{s}$

The y-component of the velocity of this time is

$v_y = -0.5 \times 3 = -1.5\ \text{ms}^{-1}$

248 **(a)**

Angular velocity $= \frac{2\pi}{T} = \frac{2\pi}{24}\ rad/hr = \frac{2\pi}{86400}\ rad/s$

249 **(c)**

Area $= |\vec{\text{A}}| \times |\vec{\text{B}}| = |(4\hat{\imath} + 3\hat{\jmath}) \times (2\hat{\imath} + 4\hat{\jmath})| = |10\hat{\text{k}}| = 10\text{units}$

250 **(b)**

$E_k' = E_k \cos^2 30° = \frac{3E_k}{4}$

251 **(c)**

Equating velocities along the vertical,

$v_2 = v_1 \sin 30°$ or $\frac{v_2}{v_1} = \frac{1}{2}$

252 **(d)**

$a_c = k^2 r t^4 = \frac{v^2}{r}$ or $v = krt^2$

The tangential acceleration is $a_T = \frac{dv}{dt} = 2krt$

The tangential force on the particle, $F_T = ma_T = 2mkrt$

Power delivered to the particle

$= F_T = ma_T = 2mkrt = F_T v = (2mkrt)(krt)^2$

$= 2mk^2 r^2 t^3$

253 **(c)**

$R = 4H \cot\theta$

When $R = H$ then $\cot\theta = 1/4 \Rightarrow \theta = \tan^{-1}(4)$

254 **(a)**

Since $v^2 - v_0^2 = 2\vec{\text{a}}.\vec{\text{s}} = 2\vec{\text{a}}.\left(\frac{\vec{\text{v}}+\vec{\text{v}}_0}{2}\right)t$

or $\vec{\text{v}}.\vec{\text{v}} - \vec{\text{v}}_0.\vec{\text{v}}_0 = (\vec{\text{v}} + \vec{\text{v}}_0).\vec{\text{a}}t$

or $\vec{\text{v}}.(\vec{\text{v}} - \vec{\text{a}}t) = \vec{v}_0.(\vec{\text{v}}_0 + \vec{\text{a}}t)$

255 **(a)**

The cord is most likely to break at the orientation, when mass is at B as tension in the string at this point is maximum

256 **(d)**

At the two point of the trajectory during projectile motion, the horizontal component of the velocity is same. Then,

$u\cos 60° = v\cos 45°$

$147 \times \frac{1}{2} = v \times \frac{1}{\sqrt{2}}$ or $v = \frac{147}{\sqrt{2}} \frac{\text{m}}{\text{s}}$

Initially, $u_y = u\sin 60° = \frac{147\sqrt{3}}{2}\text{m/s}$

Finally, $v_y = v\sin 45° = \frac{147}{\sqrt{2}} \times \frac{1}{\sqrt{2}} = \frac{147}{\sqrt{2}}\text{m/s}$

But$v_y = u_y + a_y t$ or $\frac{147}{2} = \frac{147\sqrt{3}}{2} - 9.8\,t$

$9.8\,t = \frac{147}{2}(\sqrt{3} - 1)$or $t = 5.49\ s$

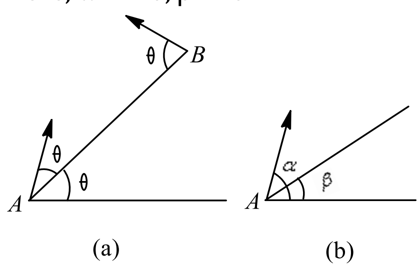
257 **(d)**

$\omega = \frac{2\pi}{T} = \frac{2\pi}{60} = 0.1047\ rad/s$

And $v = \omega r = 0.1047 \times 3 \times 10^{-2} = 0.00314\ m/s$

258 **(a)**

Here, $\alpha = 2\theta, \beta = \theta$



Time of flight of A is, $T_1 = \frac{2u\sin(\alpha-\beta)}{\text{g}\cos\beta}$

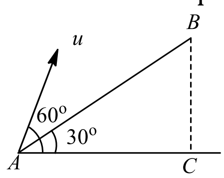
$= \frac{2u\sin(2\theta - \theta)}{\text{g}\cos\theta} = \frac{2u}{\text{g}}\tan\theta$

Time of flight of B is, $T_2 = \frac{2u\sin\theta}{\text{g}\cos\theta} = \frac{2u}{\text{g}}\tan\theta$

So, $T_1 = T_2$. The acceleration of both the particles is g downwards. Therefore, relative acceleration between the two is zero or relative motion between the two is uniform. The relative velocity of A w.r.t. B is towards AB , therefore collision will take place between the two in mid air.

259 **(d)**

Horizontal component of velocity at A



$v_H = u\cos 60° = \frac{u}{2}$ $\therefore AC = u_H \times t = \frac{ut}{2}$

$AB = AC\sec 30° = \frac{ut}{2} \times \frac{2}{\sqrt{3}} = \frac{ut}{2}$

260 **(a)**

Given, $5 = \frac{2u\sin\theta}{2g}$ or $\frac{u\sin\theta}{g} = \frac{5}{2}$

Maximum height $= \frac{u^2\sin^2\theta}{2g} = \frac{g}{2}\left(\frac{u^2\sin^2\theta}{g^2}\right)$

$= \frac{g}{2} \times \left(\frac{5}{2}\right)^2 = \frac{10}{2} \times \frac{25}{4} = 31.25$ m

261 **(a)**

Motion is along the time ; $Y = X + 4$;

Differentiating it wrt time, we have

$\frac{dY}{dt} = \frac{dX}{dt}$ $ie, v_Y = v_X$

As, $v = (v_X^2 + v_Y^2)^{1/2} = 3\sqrt{2}$ and $v_X = v_Y$, therefore,

$(v_X^2 + v_X^2)^{1/2} = 3\sqrt{2}$ or $v_X = 3 = v_Y$

When $X = 0$, from the given equation,

$Y = 0 + 4 = 4$

Magnitude o angular momentum of particle

$= m\,v\,r = m\,v\,y \quad (\because y = r)$

$= 5 \times 3 \times 4 = 60$ units

262 **(a)**

According to law of conservation of linear momentum at the highest point.

$mv\cos\theta = \frac{m}{2}(-v\cos\theta) + \frac{m}{2}v_1$

or $v_1 = 3v\cos\theta$

263 **(a)**

$\vec{B} + (\hat{i} + 2\hat{j} - 3\hat{k}) = \hat{i}$

or $\vec{B} = -2\hat{j} + 3\hat{k}$

264 **(a)**

$v_{\min} = \sqrt{5\,gr} = 17.7\ m/\text{sec}$

265 **(a)**

$\vec{A} + \vec{B} = 8\hat{i} - 2\hat{j} + 16\hat{k}$

$m = \frac{0}{|\vec{A} + \vec{B}|} = 0$

266 **(a)**

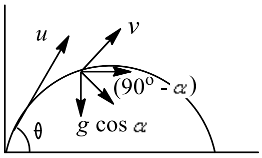
Because the reaction on inner wheel decreases and becomes zero. So it leaves the ground first

267 **(c)**

$v = \sqrt{\mu\,rg} = \sqrt{0.64 \times 20 \times 10} = 11.2\ \text{ms}^{-1}$

268 **(c)**

Refer figure when the velocity vector makes an angle α with the horizontal, the component of acceleration, perpendicular to velocity, *ie*, the centripetal acceleration is g cos α. As horizontal component of velocity remains unchanged in angular projection of projectile, hence



$v\cos\alpha = u\cos\theta$ or $v = \frac{u\cos\theta}{\cos\alpha}$

As, g cos α provides centripetal acceleration, hence

$g\cos\alpha = \frac{v^2}{r}$ or $\frac{v^2}{g\cos\alpha} = \frac{u^2\cos^2\theta}{g\cos^3\alpha}$

269 **(b)**

$T_{\text{top}} = \frac{mv^2}{r} - mg \quad$ ...(i)

$T_{\text{bottom}} = \frac{mv^2}{r} + mg \quad$ ...(ii)

$\frac{T_{\text{top}}}{T_{\text{bottom}}} = \frac{\frac{v^2}{r} - g}{\frac{v^2}{r} + g} = \frac{\frac{40\times40}{4} - 10}{\frac{40\times40}{4} + 10}$

$= \frac{400 - 10}{400 + 10} = \frac{390}{410} = \frac{39}{41}$

270 **(d)**

$|\vec{a} \times \vec{b}| = ab\ \sin\theta$

sinθcannot be greater than 1.

$\therefore |\vec{a} \times \vec{b}|$cannot be greater than ab.

271 **(b)**

Maximum height $H = \frac{v^2\cos^2\beta}{2g}$

or $v\cos\beta = \sqrt{2gH}$

$t = \frac{v\cos\beta}{g} = \frac{\sqrt{2gH}}{g}$

$t = \sqrt{\frac{2H}{g}}$

272 **(b)**

$\tan\theta = \frac{v^2}{rg} = \frac{400}{20 \times 9.8} \Rightarrow \theta = 63.9°$

273 **(b)**

$H = \frac{u^2\sin^2\theta}{2g}$ and $T = \frac{2u\sin\theta}{g} \Rightarrow T^2 = \frac{4\,u^2\sin^2\theta}{g^2}$

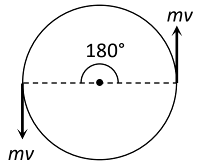
$\therefore \frac{T^2}{H} = \frac{8}{g} \Rightarrow T = \sqrt{\frac{8H}{g}} = 2\sqrt{\frac{2H}{g}}$

274 **(b)**

$v = \sqrt{3gr}$ and $a = \frac{v^2}{r} = \frac{3gr}{r} = 3g$

276 **(d)**

As momentum is vector quantity



∴change in momentum

$\Delta P = 2mv\sin(\theta/2)$

$= 2mv\sin(90) = 2mv$

But kinetic energy remains always constant so change in kinetic energy is zero

277 **(c)**

$\vec{A}+\vec{B}=\vec{C}$ (given)

So, it is given that $\vec{C}$ is the resultant of $\vec{A}$ and $\vec{B}$

∴ $C^2 = A^2 + B^2 + 2AB\cos\theta$

$3^2 = 3+3+2\times 3\times\cos\theta$

$3=6\cos\theta$ or $\cos\theta = \frac{1}{2}$ $\Rightarrow \theta\ 60°$

278 **(d)**

Angular acceleration $= \frac{d^2\theta}{dt^2} = 2\theta_2$

279 **(a)**

$\vec{A}\times\vec{B} = (4\hat{\imath}+6\hat{\jmath})\times(2\hat{\imath}+3\hat{\jmath})$

$= 12(\hat{\imath}\times\hat{\jmath}) + 12(\hat{\jmath}\times\hat{\imath}) = 12(\hat{\imath}\times\hat{\jmath}) - 12(\hat{\imath}\times\hat{\jmath}) = 0$

Again, $\vec{A}\cdot\vec{B} = (4\hat{\imath}+6\hat{\jmath})\cdot(2\hat{\jmath}+3\hat{\imath}) = 8+18=26$

Again, $\frac{|\vec{A}|}{|\vec{B}|} = \frac{\sqrt{16+36}}{\sqrt{4+9}} \neq \frac{1}{2}$

Again , $\vec{B} = \frac{1}{2}\vec{A}$

280 **(d)**

At maximum height H, the horizontal component of the velocity of the bullet $= u\cos\theta =$ $u\cos 60° = u/2$

281 **(c)**

As seen from the cart the projectile moves vertically upward and comes back.

The time taken by cart to cover 80 m

$= \frac{s}{v} = \frac{80}{30} = \frac{8}{3}$s

Given, $u = ?, v = 0, a = -g = 10\text{ms}^{-2}$

(for a projectile going upward)

and $t = \frac{8/3}{2} = \frac{4}{3}$s

From first equation of motion

$v = u + at$

$0 = u - 10\times\frac{4}{3}$

$= \frac{40}{3}\text{ms}^{-1}$

283 **(d)**

$\vec{A}\times\vec{B} = (\hat{\imath}-2\hat{\jmath}+3\hat{k})\times(3\hat{\imath}-2\hat{\jmath}+\hat{k})$

$= -2\hat{k} - \hat{\jmath} - 6(-\hat{k}) - 2\hat{\imath} + 9\hat{\jmath} - 6(-\hat{\imath})$

$= 4\hat{\imath}+8\hat{\jmath}+4\hat{k}$

Modulus is $\sqrt{4^2+8^2+4^2} = \sqrt{32+64}$

$= \sqrt{96} = 4\sqrt{6}$units.

284 **(b)**

$v = \sqrt{\mu rg} = \sqrt{0.6\times 150\times 10} = 30m/s$

285 **(a)**

In this problem it is assumed that particle although moving in a vertical loop but its speed remain constant

Tension at lowest point $T_{\max} = \frac{mv^2}{r} + mg$

Tension at highest point $T_{\min} = \frac{mv^2}{r} - mg$

$$\frac{T_{\max}}{T_{\min}} = \frac{\frac{mv^2}{r}+mg}{\frac{mv^2}{r}-mg} = \frac{5}{3}$$

By solving we get, $v = \sqrt{4gr} = \sqrt{4\times 9.8\times 2.5} =$ $\sqrt{98}\ m/s$

286 **(b)**

Range, $R = \frac{u^2\sin 2\theta}{g}$

$\therefore 20 = \frac{u^2\sin(2\times 30°)}{g}$

$\Rightarrow \frac{u^2}{g} = \frac{20}{\sin 60°} = \frac{20}{\sqrt{3}}\times 2 = \frac{40}{\sqrt{3}}$

Now, $H = \frac{u^2\sin^2\theta}{2g}$

$= \frac{40}{\sqrt{3}}\times\frac{\sin^2 30°}{2}$

$= \frac{40}{\sqrt{3}}\times\frac{\left(\frac{1}{2}\right)^2}{2} = \frac{5}{\sqrt{3}}$m

287 **(a)**

Time of flight $= \frac{2u\sin\theta}{g} = \frac{2u_y}{g} = \frac{2\times u_{\text{vertical}}}{g}$

288 **(c)**

$\vec{A}\cdot\vec{B} = AB\cos\theta = 6$

and $|\vec{A}\times\vec{B}| = AB\sin\theta = 6\sqrt{3}$

$\therefore \frac{AB\sin\theta}{AB\cos\theta} = \frac{6\sqrt{3}}{6} = \sqrt{3}$

or $\tan\theta = \sqrt{3}$

and $\theta = 60°$

289 **(c)**

All the balls are projected from the same height, therefore their velocities will be equal.

So, $v_1 = v_2 = v_3$

290 **(d)**

Horizontal range, $R = \frac{u^2\sin^2 45°}{2g} = \frac{u^2}{g}$

Maximum height, $H = \frac{u^2\sin^2 45°}{g} = \frac{u^2}{4g}$

$\therefore \frac{R}{H} = \frac{4}{1}$

291 **(d)**

In the given condition friction provides the required centripetal force and that is constant.

$i.e. m\omega^2 r =$ constant

$\Rightarrow r \propto \frac{1}{\omega^2} \therefore r_2 = r_1\left(\frac{\omega_1}{\omega_2}\right)^2 = 9\left(\frac{1}{3}\right)^2 = 1\ cm$

292 **(c)**

Change in velocity $= 2v\sin(\theta/2) = 2v\sin 20°$

293 **(d)**

A coin files off when centrifugal force just exceeds the force of friction *ie*,

$mr\omega^2 \geq \mu m$g

or $\omega \geq \frac{\sqrt{\mu g}}{r}$

Thus ω does not depend upon mass and will remain the same

294 **(b)**

$v = r\omega = 20 \times 10 cm/s = 2m/s$

295 **(b)**

For same range angle of projection should be θ and $90 - \theta$

So, time of flights $t_1 = \frac{2u\sin\theta}{g}$ and

$t_2 = \frac{2u\sin(90-\theta)}{g} = \frac{2u\cos\theta}{g}$

By multiplying $= t_1 t_2 = \frac{4u^2\sin\theta\cos\theta}{g^2}$

$t_1 t_2 = \frac{2}{g}\frac{(u^2\sin 2\theta)}{g} = \frac{2R}{g} \Rightarrow t_1 t_2 \propto R$

296 **(a)**

We know that the range of projectile projected with velocity u, making an angle θ with the horizontal direction up the inclined plane, whose inclination with the horizontal direction is θ_0, is

$R = \frac{u^2}{g\cos^2\theta_0}[\sin(2\theta - \theta_0) - \sin\theta_0]$

Here, $u = v, \theta = (90° + \theta), \theta_0 = \theta$

$\therefore R = \frac{v^2}{g\cos^2\theta_0}\{\sin[2(90° + \theta)] - \theta\} - \sin\theta\}$

$= \frac{v^2}{g\cos^2\theta_0}[\sin(180° + \theta) - \sin\theta]$

$= -\frac{v^2}{g\cos^2\theta_0}2\sin\theta = -\frac{2u^2}{g}\tan\theta\sec\theta$

$= \frac{2v^2}{g}\tan\theta$ (in magnitude)

297 **(d)**

$R = 4H\cot\theta$, if $R = 4\sqrt{3}H$ then $\cot\theta = \sqrt{3} \Rightarrow \theta = 30°$

298 **(a)**

$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times 2}{9.8}} = 0.64$ s

$v = \frac{10}{t} = 15.62\ ms^{-1}$

$\therefore a = \frac{v^2}{R} = 163\ ms^{-2}$

299 **(b)**

$\hat{n} = \frac{\vec{A}\times\vec{B}}{AB\sin\theta} = \frac{A\hat{A}\times B\hat{B}}{AB\sin\theta} = \frac{\hat{A}\times\hat{B}}{\sin\theta}$

300 **(d)**

Required angle $= \frac{\pi}{2} - \frac{5\pi}{36} = \frac{18\pi - 5\pi}{36} = \frac{13\pi}{36}$ rad

301 **(d)**

$\frac{mv^2}{r} = 10 \Rightarrow \frac{1}{2}mv^2 = 10 \times \frac{r}{2} = 1\,J$

302 **(c)**

Here, $v = 900$ km h^{-1} $= \frac{900\times 1000}{60\times 60} = 250$ ms^{-1}

g $= 9.8$ ms^{-2}

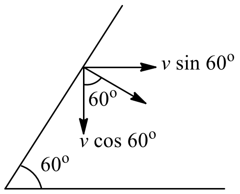
For apparent weightlessness, $\frac{mv^2}{r} = mg$

$r = \frac{v^2}{g} = \frac{250\times 250}{9.8}$

$= 6377.5$ m $= 6.4$ km

303 **(c)**

Let v be the velocity at the time of collision



Then, $u\sqrt{2}\cos 45° = v\sin 60°$

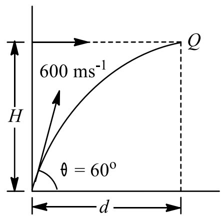
$(u\sqrt{2})\left(\frac{1}{\sqrt{2}}\right) = \frac{\sqrt{3}v}{2} \quad \therefore v = \frac{2}{\sqrt{3}}u$

304 **(a)**

If it is being hit then

$d = v_0 t + \frac{1}{2}at^2 = (u\cos\theta)t$

or $t = \frac{u\cos\theta - v_0}{a/2}$



$\therefore t = \frac{600\times\frac{1}{2} - 250}{10} = 5$ s

$H = (u\sin\theta)t - \frac{1}{2}\times gt^2$

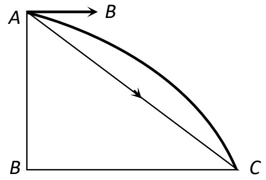
$= 600\times\frac{\sqrt{3}}{2}\times 5 - \frac{1}{2}\times 10\times 25$

$H = 2473$ m

305 **(a)**

The horizontal distance covered by the bomb,

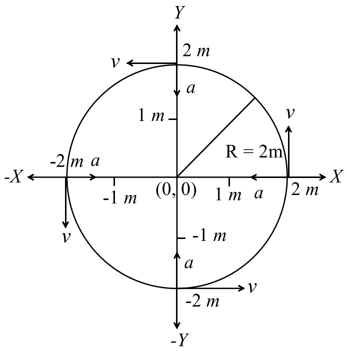
$$BC = v_H \times \sqrt{\frac{2h}{g}} = 150\sqrt{\frac{2\times 80}{10}} = 600\ m$$



∴ The distance of target from dropping point of bomb,

$$AC = \sqrt{AB^2 + BC^2} = \sqrt{(80)^2 + (600)^2}$$
$$= 605.3\ m$$

306 **(a)**



The radius of circular path is $2m$ and the speed of the object is $4m/s$

The magnitude of acceleration is

$$a = \frac{v^2}{R} = \frac{16}{2} = 8m/s^2$$

The acceleration is directed towards the centre

Therefore, when an object is at $y = 2m$, its acceleration is $-8\hat{j}\ m/s^2$

307 **(b)**

$$\overrightarrow{F} = \frac{d\overrightarrow{p}}{dt} = (-2\sin t)\hat{\imath} + (2\cos t)\hat{\jmath}$$

$$\cos\hat{\theta} = \frac{\overrightarrow{F}\cdot\overrightarrow{P}}{Fp} = 0$$

$$\therefore\ \theta = 90°$$

308 **(d)**

$\theta = 30°$

$$\frac{R}{H} = \frac{v^2(2\sin\theta\cos\theta)}{g} \times \frac{2g}{v^2\sin^2\theta} = \frac{4\cos\theta}{\sin\theta}$$

or $R = 4\cot 30° \times H = 4\sqrt{3}$

309 **(d)**

There is no loss of energy. Therefore the final velocity is the same as the initial velocity

310 **(d)**

If the three vectors are coplanar then their scalar triple product is zero. So $(\vec{A}\times\vec{C}).\vec{B} = 0$

or $\left[(2\hat{\imath} + 3\hat{\jmath} - 2\hat{k}) \times (-\hat{\imath} + 2\hat{\jmath} + 3\hat{k})\right].\left[5\hat{\imath} + a\hat{\jmath} + \hat{k}\right] = 0$

or $\left[13\hat{\imath} - 4\hat{\jmath} + 7\hat{k}\right].\left[5\hat{\imath} + a\hat{\jmath} + 5\hat{k}\right] = 0$

or $65 - 4a + 7 = 0$ or $a = 18$

311 **(d)**

Centripetal acceleration, $a_c = \frac{v^2}{R}$

Where v is the speed of an object and R is the radius of the circle

It is always directed towards the centre of the circle. Since v and R are constants for a given uniform circular motion, therefore the magnitude of centripetal acceleration is also constant. However, the direction of centripetal acceleration changes continuously. Therefore, a centripetal acceleration is not a constant vector

312 **(c)**

$y = ax - bx^2$

For height or y to be maximum

$\frac{dy}{dx} = 0$ or $a - 2bx = 0$ or $x = \frac{a}{2b}$

$$\therefore\ y_{\max} = a\left(\frac{a}{2b}\right) - b\left(\frac{a}{2b}\right)^2 = \frac{a^2}{4b}$$

and $\left(\frac{dy}{dx}\right)_{x=0} = a = \tan\theta$

where θ = angle of projection

$\therefore\ \theta \tan^{-1}(a)$

313 **(d)**

Work done in circular motion is always zero

314 **(d)**

Given, $s = t^3 + 5$

Speed, $v = \frac{ds}{dt} = 3t^2$

and rate of change of speed, $a_t = \frac{dv}{dt} = 6t$

∴ Tangential acceleration at $t = 2\ s$,

$a_t = 6 \times 2 = 12\ \mathrm{ms^{-2}}$

and at $t = 2s, v = 3(2)^2 = 12\mathrm{ms^{-1}}$

∴ Centripetal acceleration, $a_c = \frac{v^2}{R} = \frac{144}{20}\mathrm{ms^{-2}}$

∴ Net acceleration $= a_t^2 + a_i^2 \approx 14\mathrm{ms^{-2}}$

315 **(c)**

At the two points of the trajectory during projection, the horizontal component of the velocity is the same

$\Rightarrow u\cos 60° = v\cos 45°$

$$\Rightarrow 147 \times \frac{1}{2} = v \times \frac{1}{\sqrt{2}} \Rightarrow v = \frac{147}{\sqrt{2}}\ m/s$$

Vertical component of $u = u\sin 60° = \frac{147\sqrt{3}}{2}\ m$

Vertical component of $v = v\sin 45° = \frac{147}{\sqrt{2}} \times \frac{1}{\sqrt{2}}$

$$= \frac{147}{2}\ m$$

but $v_y = u_y + a_y^t \Rightarrow \frac{147}{2} = \frac{147\sqrt{3}}{2} - 9.8t$

$$\Rightarrow 9.8t = \frac{147}{2}(\sqrt{3} - 1) \Rightarrow t = 5.49\ s$$

316 **(b)**

According to given problem $\frac{1}{2}mv^2 = as^2$

$\Rightarrow v = s\sqrt{\frac{2a}{m}}$

So$a_R = \frac{v^2}{R} = \frac{2as^2}{mR}$ ...(i)

Further more as

$a_t = \frac{dv}{dt} = \frac{dv}{ds}.\frac{ds}{dt} = v\frac{dv}{ds}$...(ii)

[By chain rule]

Which is light of equation (i) i.e. $v = s\sqrt{\frac{2a}{m}}$ yields

$a_t = \left[s\sqrt{\frac{2a}{m}}\right]\left[\sqrt{\frac{2a}{m}}\right] = \frac{2as}{m}$...(iii)

So that $a = \sqrt{a_R^2 + a_t^2} = \sqrt{\left[\frac{2as^2}{mR}\right]^2\left[\frac{2as}{m}\right]^2}$

Hence $a = \frac{2as}{m}\sqrt{1 + [s/R]^2}$

$\therefore F = ma = 2as\sqrt{1 + [s/R]^2}$

317 **(b)**

Because here tension is maximum

318 **(b)**

When a body is projected at an angle θ with the horizontal with initial velocity u, then the horizontal range R of projectile is

$R = \frac{u^2 \sin 2\theta}{g}$

Clearly, for maximum horizontal range $\sin 2\theta = 1$ or $2\theta = 90°$ or $\theta = 45°$. Hence, in order to achieve maximum range, the body should be projected at 45°.

In this case

$R_{\max} = \frac{u^2}{g}$

Hence, range of A and C are less than that of B.

319 **(b)**

$\hat{A} \cdot \hat{B} = (1)(1)\cos 0° = 1 \neq AB$.

320 **(b)**

$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 490}{9.8}} = \sqrt{100} = 10$ s

$x = vt = \left(60 \times \frac{5}{18}\right) \text{ms}^{-1} \times 10 \text{ s} = \frac{500}{3}$ m

321 **(d)**

Since range is given to be the same therefore the other angle is $(90° - 30°)$, *ie*, 60°

$H = \frac{v^2 \sin^2 30°}{2g} = \frac{1}{4}\left[\frac{v^2}{2g}\right]$

$H' = \frac{v^2 \sin^2 60°}{2g} = \frac{3}{4}\left[\frac{v^2}{2g}\right]$

$\frac{H'}{H} = \frac{3}{4} \times \frac{4}{1} = 3$ or $H' = 3H$

322 **(c)**

The vertical component of velocity of the balls will be same if they stay in air for the same period of time. Hence vertical height attained will be same

323 **(b)**

Change in momentum is the product of force and time

$\Delta p = mg \times \frac{2\sin\theta}{g}$

$= 2mv\sin\theta = 2mv\sin 45° = \frac{2mv}{\sqrt{2}} = \sqrt{2}\,mv$

324 **(c)**

Let A and B be the two forces. As per question

$\sqrt{A^2 + B^2} = 5$

or $A^2 + B^2 = 25$ (i)

and $A^2 + B^2 + 2AB\cos 120° = 13$

or $25 + 2AB \times (-1/2) = 13$

or $AB = 25 - 13 = 12$

or $2AB = 24$ (ii)

Solving (i) and (ii), we get

$A = 3$N

and $B = 4$ N

325 **(b)**

$v = \sqrt{gr} = \sqrt{10 \times 40} = 20 ms^{-1}$

326 **(b)**

$y = bx^2$

Differentiating w.r.t. t, on both sides, we get

$\frac{dy}{dt} = b2x\frac{dx}{dt} \Rightarrow v_y = 2bxv_x$

Again, differentiating w.r.t. t, on both sides, we get

$\frac{dv_y}{dt} = 2bv_x\frac{dx}{dt} + 2bx\frac{dv_x}{dt} = 2bv_x^2 + 0$

$\left[\frac{dv_x}{dt} = 0\right.$, because the particle has constant acceleration along y-direction]

As per question

$\frac{dv_y}{dt} = a = 2bv_x^2;\ v_x^2 = \frac{a}{2b} \Rightarrow v_x = \sqrt{\frac{a}{2b}}$

327 **(c)**

$v = 36\frac{km}{h} = 10\frac{m}{s}\ \therefore F = \frac{mv^2}{r} = \frac{500 \times 100}{50}$

$= 1000\ N$

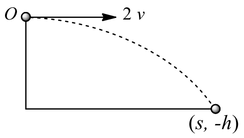
328 **(d)**

$v\cos\theta = 10\cos 60° = 5\ \text{ms}^{-1}$

329 **(b)**

Assuming particle 2 to be at rest, substituting in

$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$ $(\theta = 0°)$



We have $-h = \frac{-g}{2(4v^2)}$

or $v = \sqrt{\frac{g}{8h}}$

Which is a straight line passing through origin with slope $\sqrt{\frac{g}{8h}}$

330 **(d)**

If the string suddenly breaks, the centripetal force will be zero only tangential force will be present, then the stone travels in tangential direction.

331 **(c)**

$$a_T = \frac{dv}{dt} = \frac{d}{dt}(2t) = 2m/s^2$$

$$a_c = \frac{V^2}{r} = \frac{(2\times 3)^2}{30\times 10^{-2}} = 120\ m/s^2$$

332 **(a)**

Acceleration $= \omega^2 r = \frac{v^2}{r} = \omega v = \frac{2\pi}{T}v$

333 **(b)**

Component of velocity perpendicular to plane remains the same (in opposite direction)

ie, $u\sin\theta = 20\sin 30° = 10\ \mathrm{ms^{-1}}$

334 **(d)**

$$\tan\theta = \frac{L}{A}$$

$$\tan 30° = \frac{10v}{3400}$$

$$v = \frac{340}{\sqrt{3}} = 196.3\ \mathrm{m/s}$$

335 **(c)**

Since displacement is long the Y-direction, hence displacement $\vec{s} = 10\hat{j}$.

Work done $= \vec{F}\cdot\vec{s} = (-2\hat{i} + 15\hat{j} + 6\hat{k}).10\hat{j} = 150\ \mathrm{J}$

336 **(c)**

$\alpha = \frac{d\omega}{dt} = 0$ [As $\omega =$ constant]

337 **(a)**

$(\vec{A}+\vec{B})\cdot(\vec{A}-\vec{B}) = 0$

$A^2 - B^2 = 0$ or $A = B$.

338 **(b)**

Since range is max, therefore $\theta = 45°$

Hence, $V_x = V\cos\theta = V\cos 45° = \frac{V}{\sqrt{2}}$

At the highest point, the net velocity of the projectile is

$V_x = V\cos 45°$

$$\therefore \text{K.E.} = \frac{1}{2}mV_x^2 = \frac{1}{2}m\frac{V^2}{2} = 0.5\ K$$

339 **(a)**

$F = \frac{mv^2}{r}$. If m and v are constants then $F \propto \frac{1}{r}$

$\therefore \frac{F_1}{F_2} = \left(\frac{r_2}{r_1}\right)$

340 **(b)**

$$\omega = \frac{v}{r} = \frac{10}{100} = 0.1 rad/s$$

341 **(a)**

Here, $r = 92$ m, $v = 26\ \mathrm{ms^{-1}}$, $\mu = ?$

As $\frac{mv^2}{r} = F = \mu R = \mu mg$

$$\mu = \frac{v^2}{rg} = \frac{26\times 26}{92\times 9.8} = 0.75$$

342 **(a)**

$v_H = \sqrt{rg} = \sqrt{1\times 9.8} = 3.1\ \mathrm{ms^{-1}}$

343 **(c)**

$$R_{\max} = \frac{u^2}{g} = 100 \Rightarrow u = 10\sqrt{10} = 32\ m/s$$

344 **(d)**

$$\theta = \tan^{-1}\left(\frac{v^2}{rg}\right)$$

$$= \tan^{-1}\left[\frac{(14\sqrt{3})^2}{20\sqrt{3}\times 9.8}\right] = \tan^{-1}[\sqrt{3}]$$

$$= 60°$$

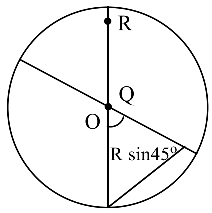
345 **(c)**

$$h_1 = \frac{v^2\sin^2\alpha}{2g}, h_2 = \frac{v^2\cos^2\alpha}{2g}, \frac{h_1}{h_2} = \tan^2\alpha$$

346 **(d)**

In complete revolution change in velocity becomes zero so average acceleration will be zero

347 **(a)**



To reach the unshaded portion particle P needs to travel horizontal range greater than $R\sin 45°$ or $(0.7\ R)$ but its range is less than $\frac{R}{2}$. So it will fall on shaded portion

Q is near to origin, its velocity will be nearly along QR so its will fall in unshaded portion

348 **(b)**

$v = \sqrt{2gh} = \sqrt{2\times 10\times 0.2} = 2\ m/s$

349 **(d)**

$\cos\theta = \frac{(\hat{i}+2\hat{j}+2\hat{k}).\hat{i}}{(1^2+2^2+2^2)^{1/2}} = \frac{1}{\sqrt{3}} = \frac{1}{3}$

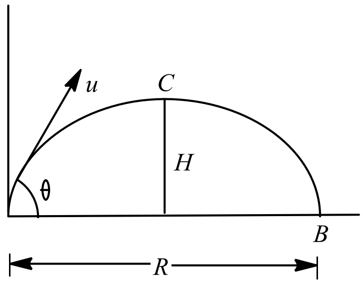
$= 0.4472 = \cos 63°12'$

350 **(b)**

$\vec{S} = (10\hat{i} - 2\hat{j} + 7\hat{k}) - (6\hat{i} + 5\hat{j} - 3\hat{k})$
$= 4\hat{i} - 7\hat{j} + 10\hat{k}$
$\vec{W} = \vec{F} \cdot \vec{S}$
$=(10\hat{i} - 3\hat{j} + 6\hat{k}) \cdot (4\hat{i} - 7\hat{j} + 10\hat{k})$
$= (40 + 21 + 60)\text{J} = 121\text{ J}$

351 **(b)**
Given, $r = 40$ m and $g = 10\text{m/s}^2$
we have $v = \sqrt{gr}$
$= 10 \times 40 = \sqrt{400}$
$= 20$ m/s

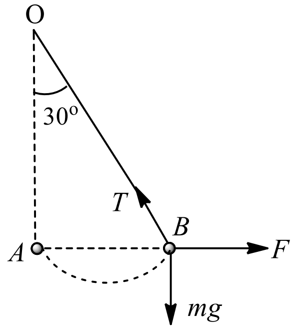
352 **(b)**
Let a body be projected at a velocity u at an angle θ with the horizontal. Then horizontal range covered is given by



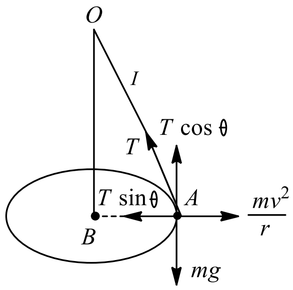
$R = \dfrac{u^2 \sin 2\theta}{g}$ ... (i)
and height H is
$H = \dfrac{u^2 \sin^2\theta}{2g}$ ... (ii)
Given, $R = 3H$
$\dfrac{u^2 \sin 2\theta}{g} = 3 \times \dfrac{u^2 \sin^2\theta}{2g}$
Also, $\sin 2\theta = 2\sin\theta\cos\theta$
$\therefore \dfrac{u^2 2\sin\theta\cos\theta}{g} = 3 \times \dfrac{u^2\sin^2\theta}{2g}$
or $2\cos\theta = 1.5\sin\theta$
or $\tan\theta = \dfrac{2}{1.5} = 1.33$
or $\theta = 53°7''$
Hence, angle of projection is $53°7'$

353 **(a)**
In this problem it is assumed that particle although moving in a vertical loop but it speed remain constant
Tension at lowest point $T_{\max} = \frac{mv^2}{r} + mg$
Tension at highest point $T_{\min} = \frac{mv^2}{r} - mg$
$$\frac{T_{\max}}{T_{\min}} = \frac{\frac{mv^2}{r} + mg}{\frac{mv^2}{r} - mg} = \frac{5}{3}$$
$\therefore v = \sqrt{4gr} = \sqrt{4 \times 9.8 \times 2.5} = \sqrt{98}\text{ms}^{-1}$

354 **(d)**
$T\cos 30° = mg$
or $T = \frac{mg}{\cos 30°} = \frac{\sqrt{3}\times 9.8}{\sqrt{3}/2} = 19.6\text{N}$
$F = T\sin 30° = 19.6 \times \frac{1}{2} = 9.8\text{N}$



355 **(a)**
In figure, $T\sin\theta = \frac{mv^2}{r}$; $T\cos\theta = mg$;



So, $\tan\theta = \frac{v^2}{rg} = \frac{r}{\sqrt{l^2 - r^2}}$
$$v = \left[\frac{r^2 g}{(l^2 - r^2)^{1/2}}\right]^{1/2} = \left[\frac{0.09 \times 10}{(0.25 - 0.09)^{1/2}}\right]^{1/2}$$
$= 1.5\text{ ms}^{-1}$

356 **(b)**
$$R = \frac{u^2 \sin 2\theta}{g} = \frac{(500)^2 \times \sin 30°}{10} = 12.5 \times 10^3\ m$$

357 **(c)**
Centripetal force is provided by friction, so
$\dfrac{mv^2}{r} < f_L$ ie, $\dfrac{mv^2}{r} < \mu mg$
$i.e$, $v < \sqrt{\mu gr}$ so that, $v_{\max} = \sqrt{\mu gr}$
Here, $\mu = 0.4$, $r = 30$m and $g = 10\text{ms}^{-2}$
$\therefore v_{\max} = \sqrt{0.4 \times 30 \times 10} = 11\text{m/s}$

358 **(d)**
Tension at mean position, $mg + \frac{mv^2}{l} = 3mg$
$v = \sqrt{2gl}$
And if the body displaces by angle θ with the vertical
Then $v = \sqrt{2gl(1 - \cos\theta)}$
Comparing (i) and (ii), $\cos\theta = 0 \Rightarrow \theta = 90°$

359 **(b)**
Centripetal force is given by
$F = \dfrac{mv^2}{R}$

$\Rightarrow F \propto \frac{1}{R}$

or $\frac{F_2}{F_1} = \frac{R_1}{R_2}$

Given, $r_2 = 2r_1$

$\therefore \frac{F_2}{F_1} = \frac{R_1}{2R_1} = \frac{1}{2}$

or $F_2 = \frac{F_1}{2}$

therefore, centripetal force will become half.

360 **(b)**

$E' = E\cos^2\theta = E\cos^2(45°) = \frac{E}{2}$

361 **(c)**

$|\vec{A} \times \vec{B}| = AB\sin\theta$. As $\sin\theta \le 1$, therefore $AB\sin\theta$ can not be more than AB.

362 **(b)**

$T = mg + \frac{mv^2}{l} = mg + 2mg = 3mg$

Where $v = \sqrt{2gl}$ from $\frac{1}{2}mv^2 = mgl$

363 **(c)**

Here, $r = 25\text{m}, v = 5\text{ ms}^{-1}, \text{m} = 500\text{ kg}$

$a_t = 1\text{ ms}^{-2}$,

$a_r = \frac{v^2}{r} = \frac{5 \times 5}{25} = 1\text{ ms}^{-2}$

$a_{\text{net}} = \sqrt{a_r^2 + a_t^2} = \sqrt{1^2 + 1^2} = \sqrt{2}\text{ms}^{-2}$

$F = ma_{\text{net}} = 500\sqrt{2}\text{N}$

364 **(d)**

$t = \sqrt{\frac{2h}{\text{g}}} = \sqrt{\frac{2 \times 980}{9.8}} = 10\sqrt{2}\text{ s}$

365 **(b)**

$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4$

$= (5\hat{i} - 5\hat{j} + 5\hat{k}) + (2\hat{i} + 8\hat{j} + 6\hat{k})$

$+(-6\hat{i} + 4\hat{j} - 7\hat{k}) + (-\hat{i} - 3\hat{j} - 2\hat{k})$

$= 4\hat{i} + 2\hat{k}$

This fore is in $y - z$ plane. Therefore, particle will move in $y - z$ plane.

366 **(a)**

$(0.5)^2 + (0.8)^2 + c^2 = 1$

$0.25 + 0.64 + c^2 = 1$

or $c^2 = 1 - 0.25 - 0.64 = 0.11$

or $c = \sqrt{0.11}$

367 **(a)**

Here, $2\pi r = 34.3 \Rightarrow r = \frac{3403}{2\pi}$ and $v = \frac{2\pi r}{T}$

$= \frac{2\pi r}{\sqrt{22}}$

Angle of banking $\theta = \tan^{-1}\left(\frac{v^2}{rg}\right) = 45°$

368 **(c)**

$P + Q = 16$ (i)

$P^2 + Q^2 + 2PQ\cos\theta = 64$ (ii)

$\tan 90° = \frac{Q\sin\theta}{P + Q\cos\theta}$

$\infty = \frac{Q\sin\theta}{P + Q\cos\theta}$

$\Rightarrow \quad P + Q\cos\theta = 0$ or $Q\cos\theta = -P$

From Eq. (ii)

$P^2 + Q^2 + 2P(-P) = 64$ or $Q^2 - P^2 = 64$

or $(Q - P)(Q + P) = 64$

or $Q - P = \frac{64}{16} = 4$ (iii)

Adding Eq. (i) and (iii), we get

$2Q = 20$ or $Q = 10$ units

From (i), $P + 10 = 16$ or $P = 6$ units

369 **(a)**

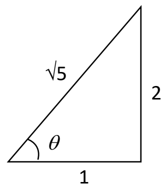
$R = 2H$ Given

We know $R = 4H\cot\theta \Rightarrow \cot\theta = \frac{1}{2}$

From triangle we can say that $\sin\theta = \frac{2}{\sqrt{5}}, \cos\theta = \frac{1}{\sqrt{5}}$

$\therefore$Range of projectile $R = \frac{2v^2\sin\theta\cos\theta}{g}$

$= \frac{2v^2}{g} \times \frac{2}{\sqrt{5}} \times \frac{1}{\sqrt{5}} = \frac{4v^2}{5g}$



370 **(b)**

$F = mr\omega^2 = mr(2\pi v)^2$ $ie, F \propto v^2$

$\frac{2F}{F} = \left(\frac{v'}{v}\right)^2$ or $v' = v\sqrt{2} = 5\sqrt{2} = 7\text{rpm}$

371 **(a)**

Displacement , $\overrightarrow{r} = (\overrightarrow{r}_2 - \overrightarrow{r}_1)$ and workdone = $\vec{F}.\overrightarrow{r}$

372 **(c)**

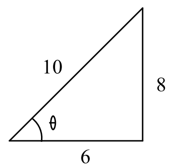
A particle performing a uniform circular motion has a transverse velocity and radial acceleration

373 **(b)**

$\vec{\mathbf{v}} = 6\hat{\mathbf{i}} - 8\hat{\mathbf{j}}$

Comparing with

$\vec{\mathbf{v}} = v_x\hat{\mathbf{i}} = v_y = \hat{\mathbf{j}}$, we get



and $u_x = 6\text{ ms}^{-2}$

Also, $u^2 = v_x^2 + v_y^2$

$36+64=100$

or $v = 10\text{ms}^{-1}$

$\sin\theta = \frac{8}{10}$ and $\cos\theta = \frac{6}{10}$

$R = \frac{v^2 \sin 2\theta}{g} = \frac{2v^2 \sin\theta\cos\theta}{g}$

$R = 2 \times 10 \times 10 \times \frac{8}{10} \times \frac{6}{10} \times \frac{1}{10}\text{ m} = 9.6\text{ m}$

374 **(b)**

$60^2 = 30^2 + v^2$ or $v^2 = 90 \times 30$

or $v = 30\sqrt{3}$ km h^{-1}.

375 **(c)**

$x + y = 16$, Also $y^2 = 8^2 + x^2$

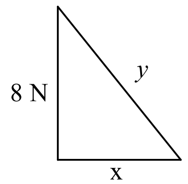
or $y^2 = 64 + (16 - y)^2$

$[\because\ x = 16 - y]$

or $y^2 = 64 + 256 + y^2 - 32y$

or $32y = 320$ or $y = 10\text{N}$

$\therefore\ x + 10 = 16$ or $x = 6\text{N}$



376 **(d)**

Maximum height and time of flight depend on the vertical component of initial velocity

$H_1 = H_2 \Rightarrow u_{y_1} = u_{y_2}$

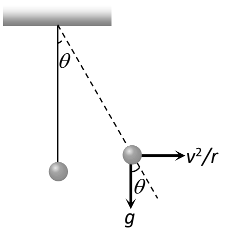
Here $T_1 = T_2$

Range $R = \frac{u^2 \sin 2\theta}{g} = \frac{2(u\sin\theta)(u\cos\theta)}{g}$

$= \frac{2u_x u_y}{g}$

$R_2 > R_1 \therefore u_{x_2} > u_{x_1}$ or $u_2 > u_1$

377 **(c)**



$\tan\theta = \frac{v^2}{rg}$

$\therefore \theta = \tan^{-1}\left(\frac{v^2}{rg}\right) = \tan^{-1}\left(\frac{10 \times 10}{10 \times 10}\right)$

$\therefore \theta = \tan^{-1}(1) = 45°$

378 **(a)**

$x = (u\cos\theta)t = 6t$

$y = (u\sin\theta)\,t - \frac{1}{2}gt^2 = 8t - 5t^2$

Therefore, $u\sin\theta = 8$

$u\cos\theta = 6$

Range. $R = \frac{u^2 2\sin 2\theta}{g}$

$= \frac{u^2 \times 2\sin\theta\cos\theta}{g}$

$= \frac{2(u\sin\theta)\,(\cos\theta)}{g}$

$= \frac{2(8)(6)}{10} = 9.6\text{ m}$

379 **(c)**

In projectile motion, horizontal component of velocity remains constant

$\therefore v\cos\theta = u\cos 2\theta$

$\Rightarrow v = \frac{u\cos 2\theta}{\cos\theta} = \frac{u(2\cos^2\theta - 1)}{\cos\theta}$

$= u(2\cos\theta - \sec\theta)$

380 **(d)**

Given $\theta_1 = \pi/3 = 30°$

Horizontal range is same if $\theta_1 + \theta_2 = 90°$

$\therefore\ \theta_2 = 90° - 30° = 60°$

$y_1 = \frac{u^2 \sin^2 30°}{2g}$ and $y_2 \frac{u^2 \sin^2 60°}{2g}$

$\therefore \frac{y_2}{y_1} = \frac{\sin^2 30°}{\sin^2 60°} = \left(\frac{1/4}{\sqrt{3}/4}\right)^2 = \frac{1}{2}$ or $y_2 = \frac{y_1}{3}$

381 **(b)**

$t = \sqrt{\frac{2h}{g}}, x = v\sqrt{\frac{2h}{g}}$ or $v = x\sqrt{\frac{g}{2h}}$

382 **(c)**

Minimum angular velocity $\omega_{\min} = \sqrt{g/R}$

$\therefore T_{\max} = \frac{2\pi}{\omega_{\min}} = 2\pi\sqrt{\frac{R}{g}} = 2\pi\sqrt{\frac{2}{10}} \cong 3s$

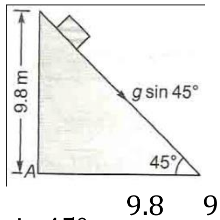
383 **(b)**

Range $= \frac{u^2 \sin 2\theta}{g}$. It is clear that range is proportional to the direction (angle) and the initial speed.

384 **(d)**

The time of ascent = time of descent = t_0

T = total time of flight = $2t_0$



$\sin 45° = \frac{9.8}{BC} = \frac{9.8}{s}$

$\therefore\ s = 9.8\sqrt{2}$

$\therefore\ s = ut + \frac{1}{2}at^2$

$$s = 0 \times t + \frac{1}{2}(g \sin 45°)t_0^2$$

or $9.8\sqrt{2} = \frac{9.8}{2\sqrt{2}} t_0^2$

$\therefore\ t_0^2 = 4$

$\therefore\ t_0 = 2s$

$\therefore\ T = 2t_0 - 4s$

385 **(b)**

The ball reaches nth step in time t, then $bn = ut$ or $t = bn/u$,

$nh = \frac{1}{2}gt^2 = \frac{1}{2}g \times \frac{b^2n^2}{u^2}$; so $n = \frac{2u^2h}{gb^2}$

Time taken to travel vertical distance nh is

$$t = \sqrt{\frac{2nh}{g}} = \sqrt{\frac{2h}{g} \times \frac{2u^2h}{gb^2}} = \frac{2uh}{gb}$$

386 **(b)**

Since the projectile is released its initial velocity is the same as the velocity of the plane at the time of release

Take the origin at the point of release

Let x and $y(= -730\text{m})$ be the coordinates of the point on the ground where the projectile hits and let t be the time when it hits. Then

$$y = -v_0 t \cos\theta - \frac{1}{2}gt^2$$

where $\theta = 53.0°$

This equation gives

$$v_0 = -\frac{y + \frac{1}{2}gt^2}{t \cos\theta}$$

$$= -\frac{-730 + \frac{1}{2}(9.8)(5)^2}{5 \cos 53°} = 202 \text{ ms}^{-1}$$

387 **(a)**

When body is released from the position p (inclined at angle θ from vertical) then velocity at mean position

$v = \sqrt{2gl(1 - \cos\theta)}$

$\therefore$ Tension at the lowest point $= mg + \frac{mv^2}{l}$

$$= mg + \frac{m}{l}[2gl(1 - \cos 60)] = mg + mg = 2mg$$

388 **(a)**

$2\pi r = 34.3 \Rightarrow r = \frac{34.3}{2\pi}$ and $v = \frac{2\pi r}{T} = \frac{2\pi r}{\sqrt{22}}$

Angle of banking $\theta = \tan^{-1}\left(\frac{v^2}{rg}\right) = 45°$

389 **(a)**

$mg = 1 \times 10 = 10N, \frac{mv^2}{r} = \frac{1 \times (4)^2}{1} = 16$

Tension at the top of circle $= \frac{mv^2}{r} - mg = 6N$

Tension at the bottom of circle $= \frac{mv^2}{r} + mg = 26N$

390 **(a)**

$\tan\theta = \frac{v^2}{rg} = \frac{30 \times 30}{900 \times 9.8} = 0.102$

$\therefore \theta = 6°$

391 **(c)**

$$a = \frac{v^2}{r} = \omega^2 r = 4\pi^2 n^2 r = 4\pi^2\left(\frac{22}{44}\right)^2 \times 1$$

$$= \pi^2 m/s^2$$

and its direction is always along the radius and towards the centre

392 **(d)**

$\omega_1 = 2\pi \times 300$ rad/min

$\omega_2 = 2\pi \times 100$ rad/min

Angular retardation

$$\alpha = \frac{\omega_1 - \omega_2}{2}$$

$$= \frac{2\pi \times 300 - 2\pi \times 100}{2}$$

$$= 2\pi \times 100 \text{ rad/min}^2$$

$$= 200\pi \text{ rad/min}^2$$

394 **(b)**

Here the tangential acceleration also exists which requires power

Given that $a_C = k^2rt^2$ and $a_C = \frac{v^2}{r} \therefore \frac{v^2}{r} = k^2rt^2$

Or $v^2 = k^2r^2t^2$ or $v = krt$

Tangential acceleration $a = \frac{dv}{dt} = kr$

Now force $F = m \times a = mkr$

So power $P = F \times v = mkr \times krt = mk^2r^2t$

395 **(c)**

Because horizontal velocity is same for coin and the observer. So relative horizontal displacement will be zero

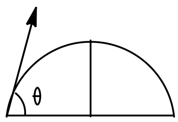
396 **(c)**

Horizontal component $= u\cos\theta$

Vertical component $= u\sin\theta$

$g = -10\text{ms}^{-2}, u = 50\text{ms}^{-1}, h = 5\text{m}, t = 2$ s

$$h = u_y t + \frac{1}{2}gt^2$$



$$\therefore\ 5 = 50\sin\theta - \frac{1}{2} \times 10 \times 4$$

or $5 = 50\sin\theta - 20$

or $\sin\theta = \frac{25}{50} = \frac{1}{2}$

$\therefore\ \theta = 30°$

397 **(d)**

For horizontal motion,

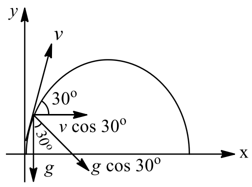
$nw = v_0 t$ or $t = \frac{nw}{v_0}$

For vertical motion, $nh = \frac{1}{2} g t^2$

or $\frac{1}{2} g \left(\frac{n^2 w^2}{v_0^2}\right) = nh$ or $n = \frac{2hv_0^2}{gw^2}$

398 **(c)**

Let v be the velocity of particle when it makes 30° with horizontal. Then



$v \cos 30° = u \cos 60°$

or $v = \frac{u \cos 60°}{\cos 30°} = \frac{20\left(\frac{1}{2}\right)}{\left(\frac{\sqrt{3}}{2}\right)} = \frac{20}{\sqrt{3}} \text{ms}^{-1}$

Now, $g \cos 30° = \frac{v^2}{R}$

or $R = \frac{v^2}{g \cos 30°} = \frac{\left(\frac{20}{\sqrt{3}}\right)^2}{(10)\frac{\sqrt{3}}{2}}$

$= 15.4$ m

1)	c	2)	c	3)	c	4)	c	197)	d	198)	c	199)	c	200)	d
5)	b	6)	d	7)	b	8)	c	201)	c	202)	c	203)	a	204)	b
9)	a	10)	b	11)	c	12)	b	205)	c	206)	b	207)	b	208)	d
13)	a	14)	c	15)	b	16)	b	209)	b	210)	c	211)	b	212)	c
17)	c	18)	c	19)	a	20)	c	213)	a	214)	d	215)	d	216)	b
21)	c	22)	d	23)	d	24)	d	217)	a	218)	d	219)	a	220)	c
25)	a	26)	a	27)	d	28)	a	221)	b	222)	d	223)	a	224)	a
29)	a	30)	b	31)	c	32)	b	225)	d	226)	d	227)	b	228)	b
33)	a	34)	d	35)	a	36)	a	229)	c	230)	c	231)	a	232)	b
37)	c	38)	c	39)	c	40)	b	233)	c	234)	d	235)	a	236)	b
41)	a	42)	a	43)	d	44)	b	237)	d	238)	c	239)	c	240)	c
45)	b	46)	c	47)	d	48)	c	241)	b	242)	b	243)	c	244)	c
49)	a	50)	d	51)	a	52)	b	245)	c	246)	d	247)	c	248)	a
53)	a	54)	a	55)	a	56)	b	249)	c	250)	b	251)	c	252)	d
57)	a	58)	c	59)	d	60)	c	253)	c	254)	a	255)	a	256)	d
61)	d	62)	d	63)	c	64)	a	257)	d	258)	a	259)	d	260)	a
65)	b	66)	a	67)	d	68)	c	261)	a	262)	a	263)	a	264)	a
69)	d	70)	c	71)	b	72)	a	265)	a	266)	a	267)	c	268)	c
73)	b	74)	c	75)	c	76)	c	269)	b	270)	d	271)	b	272)	b
77)	c	78)	c	79)	a	80)	b	273)	b	274)	b	275)	c	276)	d
81)	d	82)	c	83)	b	84)	b	277)	c	278)	d	279)	a	280)	d
85)	d	86)	d	87)	b	88)	a	281)	c	282)	b	283)	d	284)	b
89)	c	90)	c	91)	a	92)	d	285)	a	286)	b	287)	a	288)	c
93)	b	94)	a	95)	c	96)	d	289)	c	290)	d	291)	d	292)	c
97)	d	98)	b	99)	b	100)	d	293)	d	294)	b	295)	b	296)	a
101)	d	102)	a	103)	d	104)	d	297)	d	298)	a	299)	b	300)	d
105)	c	106)	c	107)	d	108)	b	301)	d	302)	c	303)	c	304)	a
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113)	b	114)	a	115)	d	116)	d	309)	d	310)	d	311)	d	312)	c
117)	d	118)	a	119)	b	120)	d	313)	d	314)	d	315)	c	316)	b
121)	a	122)	d	123)	b	124)	c	317)	b	318)	b	319)	b	320)	b
125)	a	126)	d	127)	a	128)	b	321)	d	322)	c	323)	b	324)	c
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133)	a	134)	d	135)	c	136)	d	329)	b	330)	d	331)	c	332)	a
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141)	a	142)	a	143)	b	144)	d	337)	a	338)	b	339)	a	340)	b
145)	d	146)	a	147)	a	148)	c	341)	a	342)	a	343)	c	344)	d
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153)	b	154)	a	155)	d	156)	c	349)	d	350)	b	351)	b	352)	b
157)	b	158)	d	159)	a	160)	b	353)	a	354)	d	355)	a	356)	b
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165)	d	166)	d	167)	a	168)	a	361)	c	362)	b	363)	c	364)	d
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173)	a	174)	b	175)	c	176)	a	369)	a	370)	b	371)	a	372)	c
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189)	a	190)	a	191)	a	192)	b	385)	b	386)	b	387)	a	388)	a
193)	d	194)	c	195)	a	196)	c	389)	a	390)	a	391)	c	392)	d

393)	c	394)	b	395)	c	396)	c
397)	d	398)	c				

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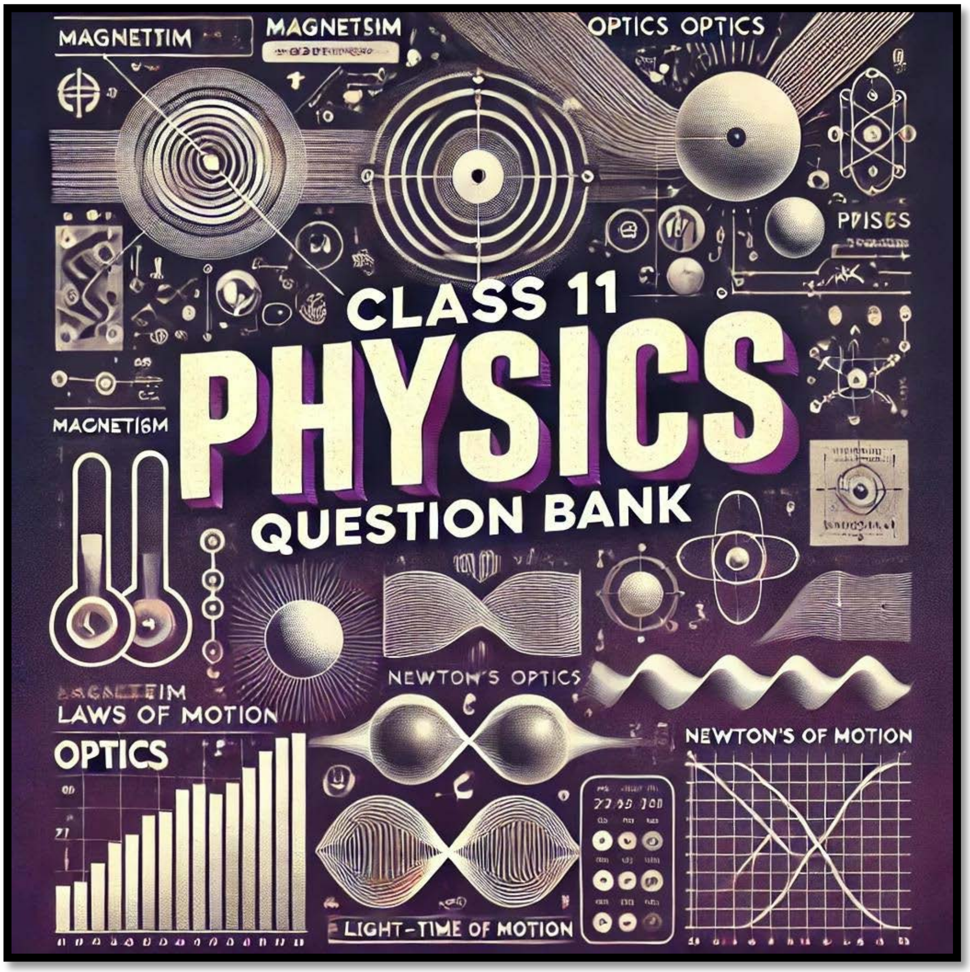

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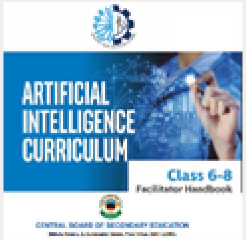

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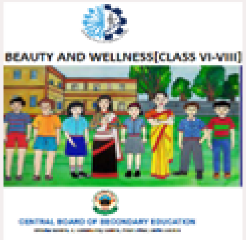
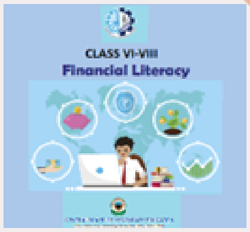


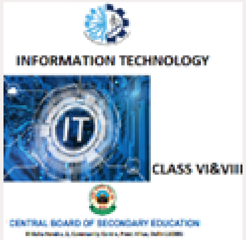
Beauty & Wellness

Design Thinking & Innovation



Financial Literacy

Handicrafts



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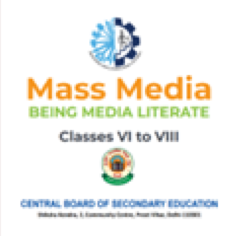
Marketing/Commercial Application



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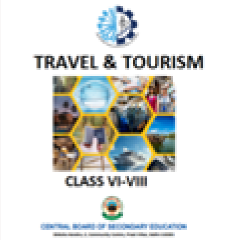

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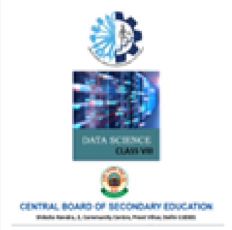

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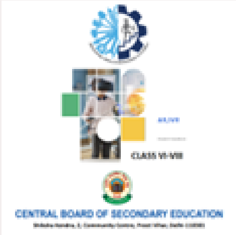
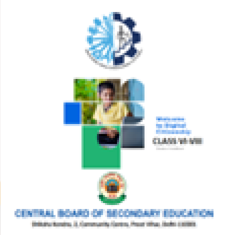
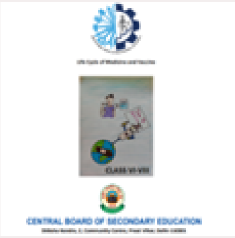


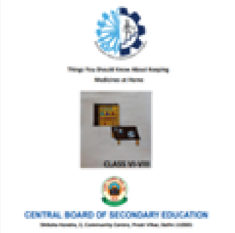
Augmented Reality / Virtual Reality



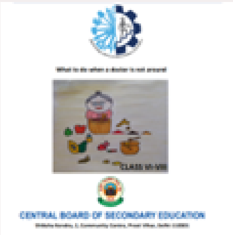
Digital Citizenship



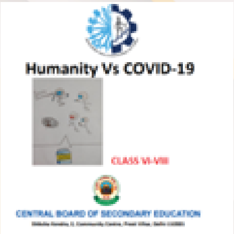
Life Cycle of Medicine & Vaccine



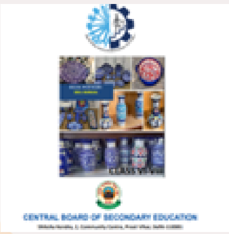
Things you should know about keeping Medicines at home



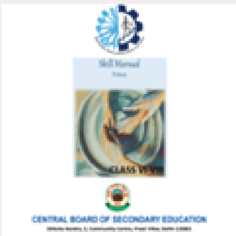
What to do when Doctor is not around



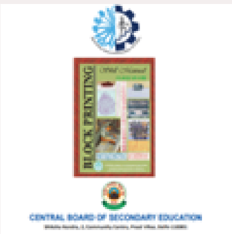
Humanity & Covid-19



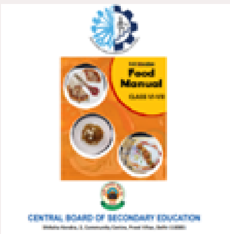
Blue Pottery



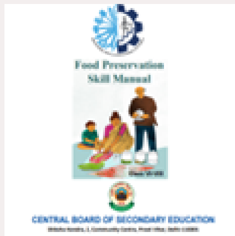
Pottery



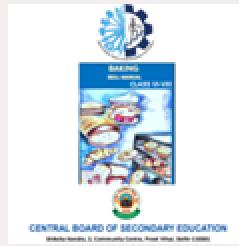
Block Printing



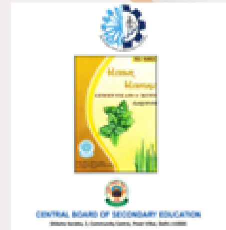
Food



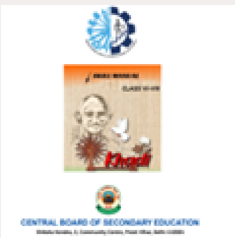
Food Preservation



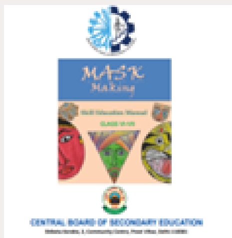
Baking



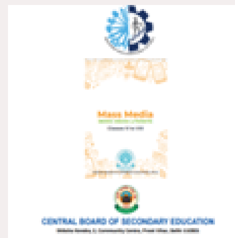
Herbal Heritage



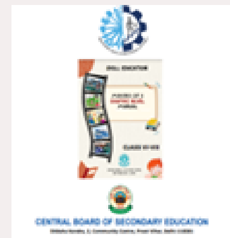
Khadi



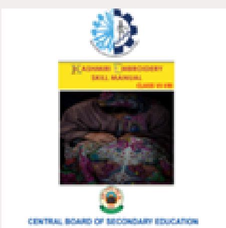
Mask Making



Mass Media



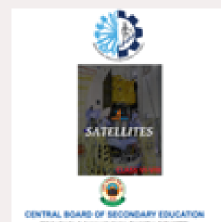
Making of a Graphic Novel



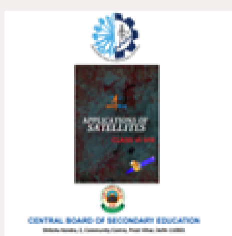
Kashmiri Embroidery

Embroidery

Rockets



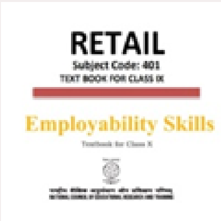
Satellites



Application of Satellites

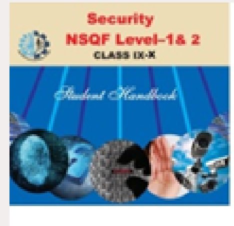
Photography

SKILL SUBJECTS AT SECONDARY LEVEL (CLASSES IX – X)

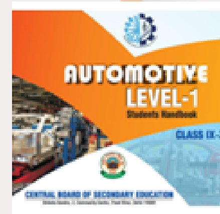


Retail

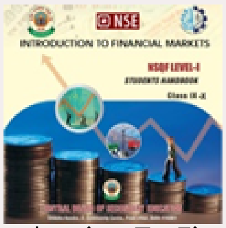
Information Technology



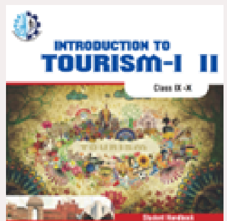
Security



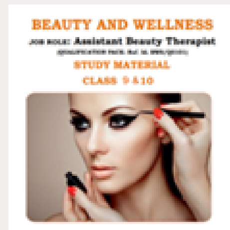
Automotive



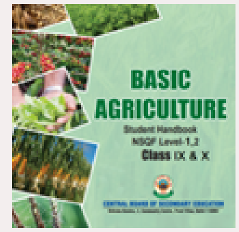
Introduction To Financial Markets



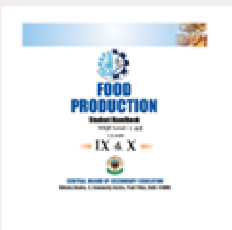
Introduction To Tourism



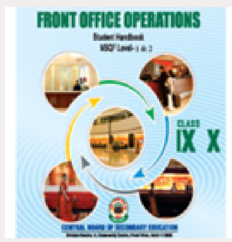
Beauty & Wellness



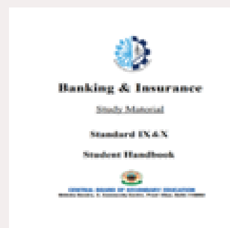
Agriculture



Food Production

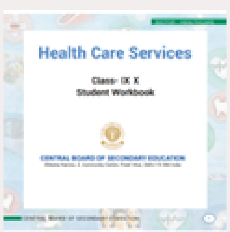


Front Office Operations



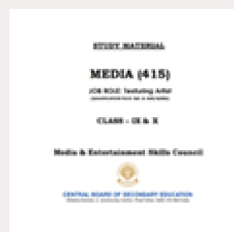
Banking & Insurance

Marketing & Sales

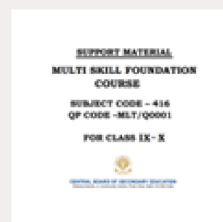


Health Care

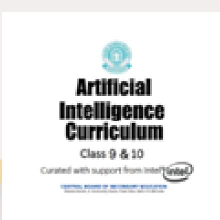
Apparel



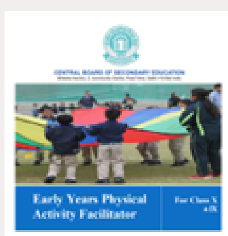
Multi Media



Multi Skill Foundation Course



Artificial Intelligence

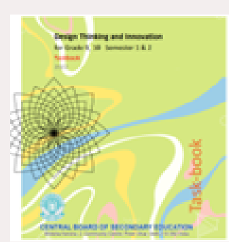


Physical Activity Trainer

Data Science

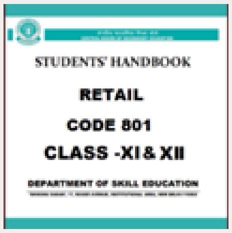

Electronics & Hardware (NEW)

Foundation Skills For Sciences (Pharmaceutical & Biotechnology)(NEW)

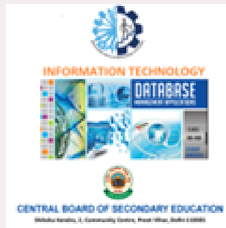


Design Thinking & Innovation (NEW)

SKILL SUBJECTS AT SR. SEC. LEVEL (CLASSES XI – XII)

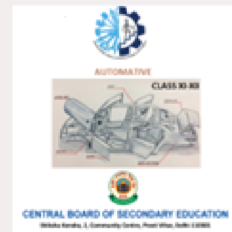


Retail



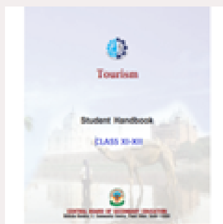
InformationTechnology

Web Application

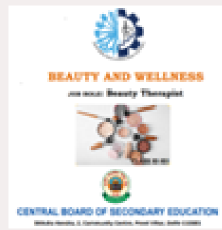


Automotive

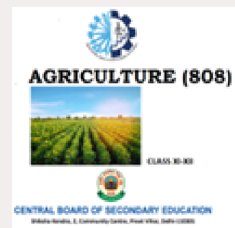
Financial Markets Management



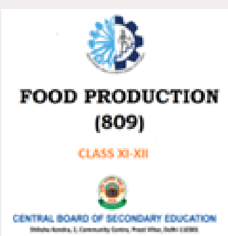
Tourism



Beauty & Wellness

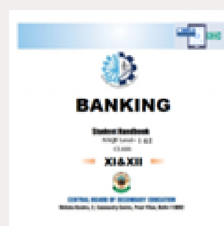


Agriculture

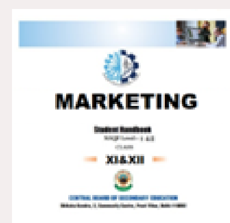


Food Production

Front Office Operations

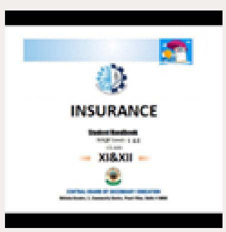


Banking

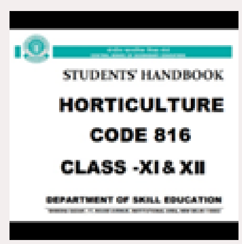


Marketing

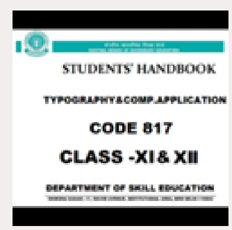
Health Care



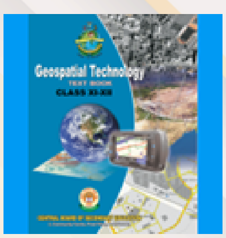
Insurance



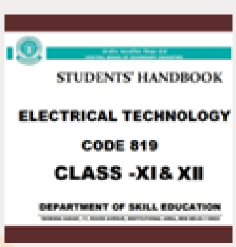
Horticulture



Typography & Comp. Application

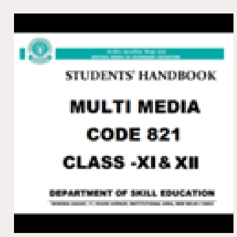


Geospatial Technology

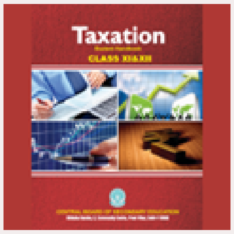


Electrical Technology

Electronic Technology

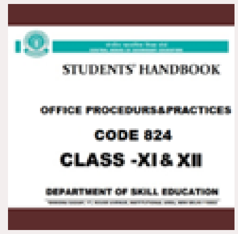


Multi-Media

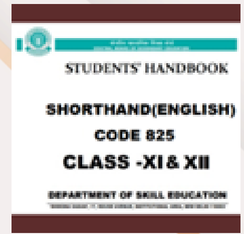


Taxation

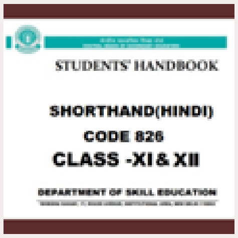
Cost Accounting



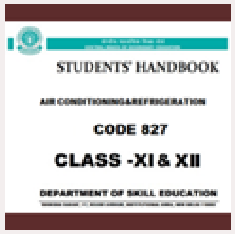
Office Procedures & Practices



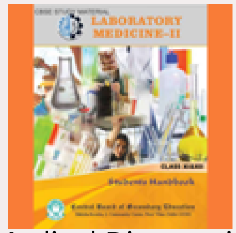
Shorthand (English)



Shorthand (Hindi)

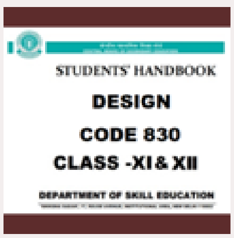


Air-Conditioning & Refrigeration

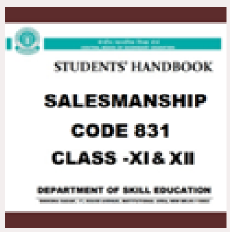


Medical Diagnostics

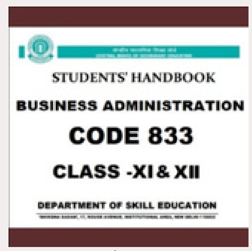
Textile Design



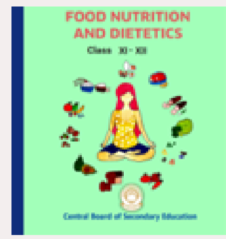
Design



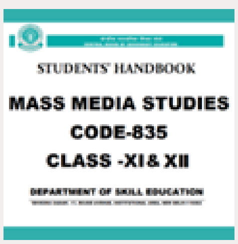
Salesmanship



Business Administration

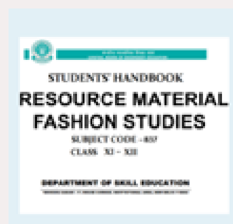


Food Nutrition & Dietetics

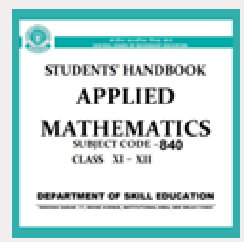


Mass Media Studies

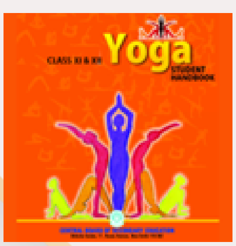
Library & Information Science



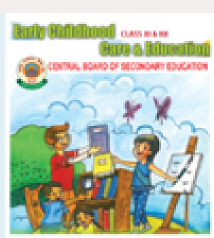
Fashion Studies



Applied Mathematics



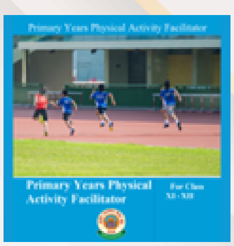
Yoga



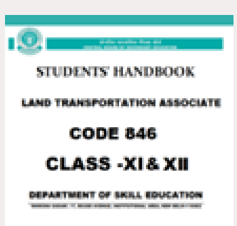
Early Childhood Care & Education

Artificial Intelligence

Data Science



Physical Activity Trainer(new)



Land Transportation Associate (NEW)

Electronics & Hardware (NEW)

Design Thinking & Innovation (NEW)

Subject Wise Secondary and Senior Secondary Groups IX & X

Secondary Groups (IX & X)

Click Here to Join
SST

Click Here to Join
Mathematics

Click Here to Join
Science

Click Here to Join
English

Click Here to Join
Hindi-A

Click Here to Join
Hindi-B

Click Here to Join
IT Code-402

Click Here to Join
IT

Click Here to Join
Artifical intelligence

Senior Secondary Groups XI & XII

Click Here to Join
Physics

Click Here to Join
Chemistry

Click Here to Join
English

Click Here to Join
Mathematics

Click Here to Join
Biology

Click Here to Join
Accountancy

Click Here to Join
Economics

Click Here to Join
BST

Click Here to Join
History

Click Here to Join
Geography

Click Here to Join
Sociology

Click Here to Join
Hindi Elective

Click Here to Join
Hindi Core

Click Here to Join
Home Science

Click Here to Join
Sanskrit

Click Here to Join
Psychology

Click Here to Join
Political Science

Click Here to Join
Painting

Click Here to Join
Vocal Music

Click Here to Join
Comp. Science

Click Here to Join
IP

Click Here to Join
Physical Education

Click Here to Join
APP. Mathematics

Click Here to Join
Legal Studies

Click Here to Join
Entrepreneurship

Click Here to Join
French

Click Here to Join
IIT/NEET

Click Here to Join
Artifical intelligence

Click Here to Join
CUET

Join School of Educators CBSE Telegram Groups

Join us on Telegram
Kindergarten

Join us on Telegram All classes	Join us on Telegram Class 1	Join us on Telegram Class 2
Join us on Telegram Class 3	Join us on Telegram Class 4	Join us on Telegram Class 5
Join us on Telegram Class 6	Join us on Telegram Class 7	Join us on Telegram Class 8
Join us on Telegram Class 9	Join us on Telegram Class 10	Join us on Telegram Class 11 (Sci)
Join us on Telegram Class 11 (Com)	Join us on Telegram Class 11 (Hum)	Join us on Telegram Class 12 (Sci)
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